Engineering Library

The Engineer.

Established 1856. Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 28, ESSEX ST., STRAND, LONDON, W.C. 2.

VOL. CL.—No. 3905] LONDON: FRIDAY EVENING, NOVEMBER 14, 1930 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.
ARRANGED FOR CARD INDEXING.

New Mining Electrical Control Gear. (P. 546)
THE ENGINEER, 14 - 11 - 30.

Thomas Hawksley Lecture: "The Machinery of the Earth." (P. 532)
(J. W. GREGORY.) THE ENGINEER, 14 - 11 - 30.

Heating and Drying of Granular Materials No. II. (P. 530)
(W. GILBERT.) THE ENGINEER, 14 - 11 - 30.

The "Lion" Locomotive. (P. 535)
THE ENGINEER, 14 - 11 - 30.

Future Development of the Steam Cycle No. II. (P. 538)
(K. BAUMANN.) THE ENGINEER, 14 - 11 - 30.

Large Drilling Machine for Columns. (P. 548)
THE ENGINEER, 14 - 11 - 30.

Metropolitan Water Board—Annual Report. (P. 536)
THE ENGINEER, 14 - 11 - 30.

A Brake Testing Machine. (P. 549)
THE ENGINEER, 14 - 11 - 30.

Heavy-Duty Butt Welding Machine. (P. 540)
THE ENGINEER, 14 - 11 - 30.

INDEX TO ADVERTISEMENTS, PAGE 77.

PUBLIC NOTICES

HEATING, &c.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Thursday, 27th November, 1930, for INSTALLATION of a HOT-WATER HEATING SYSTEM at Somerset House, W.C.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the Contracts Branch, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to The Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 6079

The Director-General, India Store Department, Belvedere-road, Lambeth, London, S.E. 1, invites TENDERS for :—
MATERIALS for CONVERSION of LOCOMOTIVE BOILERS to SUPERHEAT.
Tenders due 28th November, 1930.
Forms of Tender available from the above at a fee of 5s., which will not be returned. 6086

Civil Service Commission.
The Home Office announces forthcoming VACANCIES for INSPECTORS of FACTORIES, Class II. (Men and Women). Salary £200, rising by £15 a year to £350, with the usual Civil Service bonus in addition. The initial salary plus bonus at present rates would amount to £291. The appointments carry prospect of promotion to the higher grades.
A competition for these vacancies is about to be held by the Civil Service Commissioners, in consultation with the Home Office. It is anticipated that there will be 17 vacancies by the 1st April next.
Candidates must be over 23 and under 32 years of age on 1st January, 1931, but applications from candidates over 32 with exceptional qualifications will be considered.
The Regulations for the competition and forms of application may be obtained on request, preferably by postcard, from the INDUSTRIAL DIVISION, Home Office, London, S.W. 1. The latest date for receipt of applications is 8th December. 6021

The Government of INDIA invite APPLICATIONS for an APPOINTMENT of ASSISTANT ENGINEER (INSPECTION) in the Indian Stores Department for Steel Rolling Stock Inspection Work.
QUALIFICATIONS AND CONDITIONS.—Candidates, who should be unmarried, should have served a full apprenticeship or pupilage with firm of steel railway wagon builders or in railway workshops and possess drawing-office experience. Special experience of the construction of steel railway wagons and knowledge of theory and design of steel rolling stock also necessary. The possession of a University Degree in Civil or Mechanical Engineering or its equivalent desirable, but applications from those possessing other suitable theoretical qualifications will be considered. Age should be between 22 and 36 years.
Agreement for five years in first instance. Pay, Rs. 500, rising by annual increments of Rs. 50 to Rs. 750 a calendar month and certain allowances (approximate sterling equivalent of pay at current rate of exchange £450-£675 per annum). Free first-class passage to India. Provident Fund. Strict medical examination.
Further particulars and forms of application may be obtained upon request by postcard from the HIGH COMMISSIONER FOR INDIA, General Department, India House, Aldwych, London, W.C. 2. Last date for the receipt of applications 6th December, 1930. 6055

Armourers and Brasiers' Company.
LECTURES IN METALLURGY.
The Company have arranged for COURSES of THREE LECTURES to be delivered as follows :—
At KING'S COLLEGE, Strand, W.C. 2, at 5.30 p.m. on the 17th NOVEMBER, 24th NOVEMBER, and 1st DECEMBER, 1930, by Professor B. P. HAIGH, D.Sc., M. Inst. C.E.,
on
BRITTLE FRACTURE IN METALS.
At the BOROUGH POLYTECHNIC INSTITUTE, St. George's-circus (near the Elephant and Castle, S.E.), at 6.30 p.m., on the 14th NOVEMBER, 21st NOVEMBER, and 28th NOVEMBER, 1930, by Professor J. T. MACGREGOR-MORRIS, M.I.E.E.,
on
IRON, NICKEL AND HIGHLY PERMEABLE ALLOYS.
ADMISSION FREE, without Ticket. 6038

County Borough of Wallasey.
FERRIES DEPARTMENT.
TENDERS are INVITED for the CONSTRUCTION and DELIVERY at Seacombe of EIGHT MILD STEEL PONTOONS, approximately 90ft. by 11ft. by 6ft. Early delivery of the first unit and of the remainder in rapid sequence will be necessary.
Tender forms and specification with blue prints may be obtained on application to the office of the Ferries General Manager, Seacombe Ferry, Wallasey.
A deposit of One Guinea must accompany each application, which sum will be returned upon receipt of a bona fide Tender.
The Corporation do not bind themselves to accept the lowest or any Tender.
Completed forms of Tender must reach me in sealed envelopes, endorsed "Tender—Pontoons," not later than Noon on Tuesday, 25th November, addressed to the Chairman of the Ferries Committee, c.o. Town Clerk, Town Hall, Wallasey.
By Order,
GEO. LIVSEY,
Town Clerk.
Town Hall,
Wallasey.
12th November, 1930. 6080

Great Southern Railways.
DRAUGHTSMAN.
The Directors of the Great Southern Railways REQUIRE the SERVICES of an experienced DRAUGHTSMAN.
Applicants should not exceed 35 years of age and should have a sound knowledge of Civil Engineering. Commencing salary £250 per annum.
Applications should state age and give full particulars of training and experience, be accompanied by not more than two copies of recent testimonials, and should be posted so as to reach the undersigned not later than 5 p.m. on the 1st December, 1930.
H. S. COE, Secretary.
Kingsbridge Station,
Dublin, W. 6, November, 1930. 6068

Bengal-Nagpur Railway Company, LIMITED.
The Directors are prepared to receive TENDERS for :
(A) 500 ROLLED STEEL DISC WHEELS.
(B) 219 STEEL AXLES.
(C) 540 STEEL TYRES.
Specifications and forms of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after Wednesday, 12th November, 1930.
A fee of 20s. will be charged for each copy of Specification A, and of 10s. for each copy of Specifications B and C, which are NOT returnable.
Tenders must be submitted not later than Noon on Friday, 28th November, 1930.
The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.
By Order of the Board,
R. GRANT,
Secretary.
6066

East Lothian Western District WATER BOARD.
HOPES RESERVOIR.
CONTRACT NO. 2—CAST IRON SEGMENTS.
The Board invite TENDERS for the SUPPLY of about 40 TONS of CAST IRON SEGMENT PLATES, together with BOLTS, NUTS, WASHERS, &c., for the same.
Drawing may be seen and copy of specification obtained on application to Messrs. G. H. Hill and Sons (Manchester), Civil Engineers, 40, Kennedy-street, Manchester, upon the receipt of a cheque for Two Guineas, which will be returned to the applicant provided that he shall have sent in a bona fide Tender and shall not have withdrawn the same and shall have returned the documents lent to him.
A limited number of copies of the drawing are available, and will be lent to persons tendering in priority of application, on payment of the sum of Half-a-Guinea, which sum will not be returned.
Sealed Tenders, endorsed "Tender for Cast Iron Segments, Hopes Reservoir," must be forwarded to the undersigned on or before the 2nd day of December, 1930.
GEORGE CRUICKSHANK,
Clerk and Treasurer.
County Buildings, Haddington,
5th November, 1930. 6049

PUBLIC NOTICES

The County of London Electric SUPPLY CO., LTD.
BARKING POWER STATION EXTENSIONS, 1930.
TENDERS FOR THE SUPPLY OF STEEL-FRAME BUILDINGS FOR POWER STATION.
The County of London Electric Supply Company, Limited, are prepared to receive TENDERS for the SUPPLY and ERECTION of STEEL-FRAME BUILDINGS in connection with Extensions to the Power Station at Barking.
Specifications may be obtained by manufacturers of Steel-frame Buildings from the offices of the Company by application on or after Monday, 17th November, 1930, and on payment of a fee of £5 5s. for the first copy and £2 2s. for every subsequent copy. Sums paid for any number of copies up to three will be refunded on receipt of a bona fide Tender.
Sealed Tenders, endorsed "Tender for Steel-frame Buildings for Power Station," must be delivered, addressed to the CHAIRMAN and MANAGING DIRECTOR, The County of London Electric Supply Co., Ltd., County House, 46/47, New Broad-street, London, E.C. 2, not later than Noon on Thursday, 18th December, 1930.
The Company do not bind themselves to accept the lowest or any Tender. 6050

The County of London Electric SUPPLY CO., LTD.
BARKING POWER STATION EXTENSIONS, 1930.
TENDERS FOR THE SUPPLY OF OFFICES AND SWITCH-HOUSE BUILDINGS.
The County of London Electric Supply Company, Limited, are prepared to receive TENDERS for the SUPPLY and ERECTION of OFFICES and SWITCH-HOUSE in connection with the Extensions to the Power Station at Barking.
The specification, schedule and form of Tender can be obtained from Sir Alexander Gibb and Partners, Queen Anne's Lodge, Westminster, S.W. 1, on or after Monday, 17th November, 1930, and on payment of a fee of £5 5s., which sum will be returned on receipt of a bona fide Tender.
Sealed Tenders, endorsed "Tender for Offices and Switch-house Buildings," must be delivered, addressed to the CHAIRMAN and MANAGING DIRECTOR, The County of London Electric Supply Co., Ltd., County House, 46/47, New Broad-street, London, E.C. 2, not later than Noon on Tuesday, 2nd December, 1930.
The Company do not bind themselves to accept the lowest or any Tender. 6051

PUBLIC NOTICES

PATENTS AND DESIGNS ACTS, 1907 TO 1928.
Notice is Hereby Given that the RAYBESTOS COMPANY, of 1427, Railroad-avenue, Bridgeport, Connecticut, U.S.A., SEEK LEAVE to AMEND the SPECIFICATION of LETTERS PATENT No. 128,706, granted to Sumner Simpson for an invention entitled "Improvements in Clutch and Brake Friction Facings and in the Process of Making the same."
Particulars of the proposed Amendment were set forth in No. 2180 of the "Illustrated Official Journal (Patents)," published on October 29th, 1930.
Any person or persons may give notice of Opposition to the Amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton-buildings, London, W.C. 2, within one calendar month from the date of publication of the said Journal.
W. S. JARRATT,
6062 Comptroller-General.

Hertfordshire County Mental HOSPITAL.
HILL END, ST. ALBANS.
TO BUILDERS AND CONTRACTORS.
ERECTION OF WATERWORKS.
NOTICE IS HEREBY GIVEN that the Visiting Committee of the Hertfordshire County Mental Hospital at Hill End are prepared to receive TENDERS for the ERECTION of an ENGINE HOUSE, REINFORCED CONCRETE WATER TOWER, and other works in connection therewith in the grounds of the Mental Hospital at Hill End, near St. Albans, in accordance with the drawings prepared by the Consulting Engineer, Mr. J. Mackworth Wood, M. Inst. C.E., of 11, Cavendish-mansions, Langham-street, Portland-place, London, W. 1, to whom applications IN WRITING (accompanied by a returnable deposit of £5) should be made for the bills of quantities and forms of Tender.
The drawings and specifications may be inspected at the above-named Hospital, on and after Monday, the 1st December, 1930, BETWEEN THE HOURS OF 11 a.m. and 3 p.m.
Tenders, on the prescribed forms, to be addressed to "The Clerk to the Visiting Committee," and endorsed "Tender for Engine House, Water Tower, &c.," must be sent in a sealed envelope and delivered at the office of the Clerk to the Visiting Committee, Clerk of the Peace Office, Hertford, not later than Ten o'clock in the forenoon of Monday, the 15th December, 1930.
Tenders will only be received subject to the terms of the draft contract, which, together with the plans, may be inspected at the office of the Consulting Engineer.
The Visiting Committee will not be bound to accept the lowest or any Tender.
ELTON LONGMORE,
Clerk to the Visiting Committee.
Clerk of the Peace Office,
Hertford,
6th November, 1930. 6061

Liverpool Corporation Water-WORKS.
VYRNWY AQUEDUCT—THIRD INSTALMENT.
CONTRACT NO. 15.—PIPE LAYING.
The Water Committee of the Liverpool Corporation are prepared to receive TENDERS from competent persons willing to enter into a contract for the LAYING of STEEL PIPES of 42in. internal diameter and other ANCILLARY WORKS, as follows :—
From Wernddu to Afon Rhaiadr and from Parc Uchaf to Lloran Ganol, in the Counties of Montgomery and Denbigh, a distance of about 5¼ miles.
The plans and sections may be inspected and copies of the specification and form of Tender obtained at the Water Engineer's Office, 55, Dale-street, Liverpool, upon payment of the sum of Five Guineas, which amount will be returned upon receipt of a bona fide Tender.
Tenders, endorsed "Tender for Pipe Laying," are to be sent through the post in a sealed envelope, addressed to "The Town Clerk, Municipal Buildings, Liverpool," so as to be delivered not later than Twelve o'clock Noon on Tuesday, 16th December, 1930.
The Water Committee do not bind themselves to accept the lowest or any Tender.
WALTER MOON,
Town Clerk.
Municipal Buildings, Liverpool,
November, 1930. 6063

South Indian Railway Company, LIMITED.
The Directors are prepared to receive TENDERS for the SUPPLY of :—
1. ROLLED STEEL ANGLES,
2. COPPER PLATES (FLANGED), and
3. METALS.
Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.
Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Rolled Steel Angles," or as the case may be, with the name of the firm tendering, must be left with the undersigned not later than Twelve Noon on Friday, the 28th November, 1930.
The Directors do not bind themselves to accept the lowest or any Tender.
A charge, which will not be returned, will be made of 5s. for each copy of Specifications Nos. 1 and 2, and 2s. 6d. for each copy of Specification No. 3.
Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.
A. MUIRHEAD,
Managing Director.
91, Petty France, Westminster, S.W. 1.
12th November, 1930. 6088

PUBLIC NOTICES (continued) Page 2.
SITUATIONS OPEN Page 2.
SITUATIONS WANTED, Page 2.
AUCTIONS, Page 78.
MISCELLANEOUS. Page 2.
EDUCATIONAL, Page 2.
MACHINERY, &c., WANTED, Page 78.
PATENTS, Page 2.
FOR SALE, Pages 4 and 78.
BUSINESSES and PREMISES (For Sale, etc.). Page 78.
AGENCIES, Page 4.
WORK WANTED, Page 4.
FOR HIRE, Page 2.

For Advertisement Rates see Leader Page.

PUBLIC NOTICE

Government of Bombay.

NOTICE.

TO IRRIGATION DEPARTMENTS, PORT AUTHORITIES, RAILWAYS, MUNICIPALITIES, ELECTRIC SUPPLY COMPANIES, PUBLIC WORKS CONTRACTORS AND OTHER ADMINISTRATIONS CARRYING OUT LARGE ENGINEERING WORKS.

Notice is hereby given that,owing to the approaching completion of the Lloyd Barrage at Sukkur, large quantities of Plant and Machinery as briefly detailed in the list below will shortly become available for sale. The bulk of the plant will not be available until after June, 1931, but some plant is now available and other plant will become available shortly.

All Administrations who have works in progress or who are contemplating works in the near future are invited to consider the subjoined list and to apply to the undersigned for full particulars and prices of any plant which might be of use to them. Enquiries are NOT invited from machinery dealers at the present stage. Most of the plant was purchased new for these works and is in excellent condition. Every item of plant sold will be first overhauled and put in thorough working order before sale and will be open for inspection (and test, wherever possible) by appointment at Sukkur.

Service will also be given after sale and purchasers' men will be trained by arrangements, as long as the Barrage Construction Works and Shops are in existence.

A. A. MUSTO,
C.I.E., M.I.C.E., I.S.E.,
Superintending Engineer, Lloyd Barrage Circle.
Postal Address :
Sukkur, Sind, India.

LIST OF PLANT & MACHINERY.

RAILWAYS.

About 40 miles of 5ft. 6in. gauge Railway complete and 9 Steam Locomotives and about 700 Wagons of all types, including 20-Ton Either-side Tipping Wagons. About 25 miles 2ft. gauge Railway complete and 15 Kerosine and 2 Steam Locos. and about 1100 Either-side Steel Tip Wagons of 27 cubic feet capacity.

FLEET.

Two Shallow-draught Suction Dredgers, by Lobnitz, 20in. discharge, to dredge to 30ft. each, complete with 1000ft. Floating Pipe Line and Terminal Pontoon with 150ft. overhang at 40ft. above water line.

Also Shallow-draught Paddle and Twin-screw Tugs, Motor Launches, Steel Barges, Pontoons, &c.

NOTE.—All motors on electrically driven plant are for A.C., 440 volts, 3-phase, 50 periods.

CRANES.

25-Ton and 10-Ton Electric Floating Derrick Cranes, 10-Ton and 1½-Ton Electric Derrick Cranes, 20-Ton and 2-Ton Steam Derrick Cranes. Also 5-Ton Steam Loco. Cranes and 10-Ton Electric Loco. Cranes, 5ft. 6in. gauge. Also 15-Ton, 12-Ton and 5-Ton Electric Goliath Cranes, 15-Ton Electric Shop Gantry Crane, and 10-Ton Hand-operated All-round Derrick Cranes.

PUMPS.

Sets of 8in., 4in., 3in., and 2in. Direct-coupled Electric Centrifugal Pumps for 40ft. head.

PILE DRIVERS.

Floating and Land Sets with McKiernan-Terry Double-acting Piling Hammers, Spencer-Hopwood Boilers, Zenith Winches and Steel Frames and Leads for driving 45ft. Piling.

STONE CRUSHERS.

"Acme" Jaw Crushers, 24in. by 15in., with Elevators, Hoppers and Screens and Portable, Crusher, 12in. by 6in.

CONCRETE MIXERS.

Complete Plants for Moulding 10-Ton Blocks with Travelling Mixer Bridge carrying 2-Yard Ransome Mixers complete with Bunkers, Elevators and Batch Measuring Hoppers for materials, all electric driven. Also Steel Moulds for 10-Ton and 1½-Ton Blocks. Also Electric-driven Portable Mixers of sizes.

AIR COMPRESSORS.

Direct-coupled Electric-driven Sentinel Two-stage Compressors of 300 cubic feet capacity. Belt Drive Ditto of 550, 300, 188, and 140 cubic feet capacity respectively. Pneumatic Tools of all kinds.

DIVING GEAR AND DRESSES, &c.

ELECTRIC POWER PLANT.

Following Diesel Engines direct coupled to Alternators generating A.C., 6600 volts, 3-phase, 50 periods :—

2 Swiss Loco. 4-Cylinder Single-acting Diesels, 750 B.H.P., with Fly-wheel Alternator, 500 kW, by Oerlikon.
2 Fullagar 4-Cylinder Double-acting Diesels, 750 B.H.P., with Fly-wheel and Alternators, by English Electric Co., 500 kW.
2 Mirrlees, Bickerton and Day 6-Cylinder Single-acting Diesels, 300 H.P., with Metro-Vickers Alternators, 175 kW.
Metro-Vickers Cubicle Type Switchboard.
Johnson and Phillips Transformers, 6600 to 400 volts, of sizes.
H.T. and L.T. Overhead Transmission Poles, Cables, &c.

MORTAR MILLS.

Both Over-driven and Under-driven Type Mortar Mills, 8ft. dia. pans, with belt drive from countershaft.

WORKSHOP MACHINERY.

Lathes, Shapers, Planers, Milling Machines, Drilling Machines, Belt Air Hammers, Belt Hammers, Punching and Shearing Machines, Forges, Woodworking Machinery, Plate Rolls, Iron and Brassfoundry Equipment, Saw Sharpening Machines, &c.

QUARRY PLANT.

Compressed Air Drills of all sizes, Forging Machines, Oil Furnaces, Air Compressors, Oil Engines, Wire Saws, Channellers, &c.

STONE DRESSING PLANT.

Diamond Saws, Planers, Frame Saws, Rip Saws, Countershafts, &c.

ENGINES.

Oil Engines of various sizes.

BUILDINGS.

Steel-framed Stone Dressing Shop, 360ft. by 115ft., with 15-Ton Gantry Runway and numerous Smaller Steel Roof Trusses, &c.

STEEL SHEET PILING.

About 11,000 Tons "Universal" 15in. by 5in. by 43 lb. per square foot Interlocking S.S. Piling in 10ft., 45ft., and 50ft. lengths.

MISCELLANEOUS PLANT.

Such as Steel Riveted and Sectional Tanks of all sizes, with and without Staging, Winches, Jacks, Pulleys, Wire Ropes, Motor Lorries, and many other items.

A. A. MUSTO,
S.E.I.B.C.

MS.13/10. P.B. 49/30. 6060

PUBLIC NOTICES

A London 1930 Engineering GRADUATE, Ceylonese, DESIRES to OBTAIN PRACTICAL EXPERIENCE as ASSISTANT under agreement in Waterworks or Sanitary Engineering after December next.
Apply, DIRECTOR OF COLONIAL SCHOLARS, Crown Agents for the Colonies, 4, Millbank, quoting reference O/Sch. Aru. 6076

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, an ASSISTANT MOTOR ENGINEER for India, with first-class qualifications. Salary up to Rs. 300 per month and free furnished quarters. Return passage to be paid on approved service. Will be guided in all matters by State Rules.
No application will be considered without photograph and copies of testimonials, which will not be returned.
Apply before the 15th November to MOTOR ENGINEER to H.H. of Alwar, Hyde Park Hotel, Knightsbridge. P456 A

WANTED by Firm of Engineers' Merchants, a REPRESENTATIVE. Excellent salary and position offered to applicant who would be willing to invest up to £2000 in business.—Address, 6040, The Engineer Office. 6040 A

WANTED, ENGINEER to Act as COMPRESSED AIR INSPECTOR for a group of Collieries in South Wales.
Experience of underground conditions essential, also of Testing Apparatus and in the use of Compressed Air Apparatus in use underground.
Applicant to state full experience, age, salary required, and give references.
Address, 6082, The Engineer Office. 6082 A

A REALLY COMPETENT ENGINEER is REQUIRED for a large Transport Undertaking. Applicants must state full qualifications, commencing salary between £500/£750 per annum.—A. 11, Furness's Advertising Offices, Liverpool. 6048 A

ASSISTANT LONDON REPRESENTATIVE REQUIRED by important British Steel Manufacturers of Rails, Structural Sections, &c. Only those with good knowledge of the trade need apply, giving full details of experience and salary expected.—Address, P457, The Engineer Office. P457 A

ENGINEERING CLERK REQUIRED for Consulting Engineer's Office in London, accustomed to Technical Correspondence, Scheduling and Tabulating Information. State age, full experience and salary.—Address, P502, The Engineer Office. P502 A

ENGINEERING TECHNICAL ASSISTANT for Industrial Scientific Instruments, to Prepare Drafts, Line Drawings, Photographs, &c., for catalogue purposes. London. State age, experience, and salary required.—Address, 6075, The Engineer Office. 6075 A

MANAGING DIRECTOR (Engineering) REQUIRED for an Old-established Engineering Works in the Midlands.
Must be capable of taking entire charge and be able to introduce new lines of manufacture ; also to invest up to £3000. Salary and commission payable. Principals only.
Write, P. LEASK, Chartered Accountant, 27, Finsbury-square, E.C. 2. 511 A

REINFORCED CONCRETE DESIGNER, with at least two years' experience, REQUIRED by specialist firm in the Midlands. Salary £5 to £6 per week, according to qualifications.—Address, stating age, training and experience, P508, The Engineer Office. P508 A

REPUTED FIRM of BOILERMAKERS, Manufacturing a large range of boilers, REQUIRES an energetic and efficient REPRESENTATIVE with live connection with architects, heating engineers, laundries and general boiler users, in their Sales Department, London area.—Address, stating age, experience, and salary required, P487, The Engineer Office. P487 A

SMART YOUNG SALES ENGINEER REQUIRED by well-known Midland Firm to work the area in that district. Sound mechanical engineering essential. Not over 30.
Application must state fully education, experience, and salary required.
Address, 6074, The Engineer Office. 6074 A

INDIA.—MACHINERY IMPORTERS REQUIRE efficient SALES ENGINEER for Steam Engines, Power Plant in general, Mill Gearing, Pumps, &c.
Preference will be given to one who can handle other kinds of machinery in addition to above and who can procure sole agencies.
Useless applying without selling experience.
Remuneration, salary and commission. State age.
Address, 6073, The Engineer Office. 6073 A

WANTED, STEEL WORK ERECTION FOREMAN, who has had considerable experience of Erection of Railway Bridges under traffic conditions.
It is useless for men without this experience to apply.
Write, giving full particulars of experience and age to DORMAN, LONG and CO., Ltd., 55, Broadway, S.W. 1. 6054 A

DRAUGHTSMAN REQUIRED for Manufacturing Drawing Office of Tube Works. State age, salary and details of previous experience. Tube trade experience essential.—Address, P503, The Engineer Office. P503 A

DRAUGHTSMAN REQUIRED, Age About 30, Preferably with experience with London Constructional Engineers in designing and detailing Steel-framed Buildings under L.C.C.—Apply by letter, H. YOUNG and CO., Ltd., Thornycroft House, Smith-square, S.W. 1. 6083 A

DRAUGHTSMAN WANTED, Expert Designer of Light Steel-framed Buildings, for Constructional Engineers' London Office. State age, salary required, and when free, also full details of experience, in confidence.
Address, 6085, The Engineer Office. 6085 A

SENIOR DESIGNER DRAUGHTSMAN REQUIRED for Sheffield District, who has specialised on Heat Exchange Plant, Calorifiers, Condensers, &c.
Successful applicant must furnish proof of his ability to take entire responsibility. State age, experience, and when at liberty.
Address, 6084, The Engineer Office. 6084 A

SITUATIONS WANTED

A CHARTERED ELECTRICAL ENGINEER, 3 years' technical, 5 years' practical, and 14 years' commercial experience large firms, DESIRES CHANGE, preferably London district. Moderate salary if prospects reasonable.—Address, P482, The Engineer Office. P482 B

AN ELECTRICAL MECHANICAL ENGINEER (27) SEEKS APPOINTMENT as Assistant Works Manager or in other capacity. Power-house and works, experienced Diesels, steam and heavy electrical plant.—Address, P490, The Engineer Office. P490 B

CHIEF MECHANICAL ENGINEER of Ironworks and Collieries will shortly be disengaged to ACCEPT AGENCIES for well-known Engineering Firms for the Midlands.—Address, P492, The Engineer Office. P492 B

CIVIL ENGINEER, Public School, Ex-Service, B.Sc., 6½ years' good experience with public utility company in S. America, SEEKS POSITION at home or abroad.—Address, P420, The Engineer Office. P420 B

ENGINEER, A.M.I. Mech. E., 35 Years' Experience, charge of lighting and power plants, expert electro-galvanising. Excellent record.—WILSON, 861, High road, Goodmayes, Essex. P484 B

SITUATIONS WANTED (continued)

ENGINEER, A.M.I. Mech. E., Experienced GENERAL MANAGER, home and abroad (India and Brazil), recently returned from Brazil, is OPEN for ENGAGEMENT. Wide experience and accustomed to full control all departments, works and administration ; also handling agencies. Excellent record and highest references.—Address, P478, The Engineer Office. P478 B

ENGINEER and MANAGER DESIRES RESPONSIBLE APPOINTMENT as Manager, Engineer, or Representative. M.I. Mech. E., keen and good organiser. Had control of a large number of men. Excellent record. Future prospects the chief consideration.—Address, P486, The Engineer Office. P486 B

ENGINEER, British Subject, 15 Years Resident Buenos Aires, desirous of improving position, OFFERS SERVICES as REPRESENTATIVE in South America. Exhibition creates opportunity—my services are at your disposal.
Address, P505, The Engineer Office. P505 B

ENGINEER, Mechanical and Constructional, Good Draughtsman, just returned after 11 years in the Far East, REQUIRES POSITION abroad or to Travel as firm's Representative.—Address, P479, The Engineer Office. P479 B

ENGINEER, Own Car, REQUIRES London and Provincial TRAVELLING, SELLING, or INSTALLATION of MACHINES, or other Work with prospects.—Reply to Box T. 112, c/o Dawson's, 118, Cannon-street, London, E.C. 4. 6078 B

ENGINEER (31), Public School Education, Possessing 1st Class B.O.T. Certificate, SEEKS good POST at home or abroad. All-round experience with reciprocating, turbine and Diesel engines.—Address, P491, The Engineer Office. P491 B

ENGINEER (34), M.I. Mar. E., Chief Engineer, B.O.T., wide experience erection, maintenance, steam power plants, internal combustion engines, electrical and refrigerating machinery, &c., SEEKS PROGRESSIVE OPENING with London Firm Industrial Engineers.—Address, P499, The Engineer Office. P499 B

ERECTOR, Disengaged, 16 Yrs.' Experience aerial ropeways, also light structural steel work. Excellent references.—J. L. TEARLE, 188, Gregory-boulevard, Nottingham. P504 B

POSITION of MANAGER or WORKS MANAGER REQUIRED. Engineer, wide experience management, general engineering and foundry. Excellent references.—Address, P371, The Engineer Office. P371 B

SALES ENGINEER (30), All-round Experience Two firms, steam turbines, Diesels, electrical machinery, &c. POSITION on SALES STAFF DESIRED. Would consider other responsible position requiring initiative.—Address, P497, The Engineer Office. P497 B

TO MANUFACTURERS Wishing to Strengthen or to Start Railway Connection.—ADVERTISER (aged 59, retired) OFFERS his ASSISTANCE. Nominal salary.—Address, P489, The Engineer Office. P489 B

YOUNG MECH. ENGINEER (23) DESIRES POST home or abroad, preferably East Africa. Passed A and B of A.M.I.C.E., public school and university, 5 years' pupil, shops and drawing-office in well-known steel works.—Address, P495, The Engineer Office. P495 B

DRAUGHTSMAN DESIRES JUNIOR POST with Structural Engineers. Age 21. Good experience of general drawing-office work and detailing ; excellent references.—Address, P496, The Engineer Office. P496 B

DRAUGHTSMAN (25), Designer, Hydraulic and general engineering, DESIRES RESPONSIBLE POSITION, fully qualified, shop and D.O. experience, nine years, pass any tests ; good refs.—Address, P512, The Engineer Office. P512 B

DRAUGHTSMAN (Engineer), 30 Years' Exp., DESIRES ENGAGEMENT, whole or part-time. Oil plants, factory layouts, steam and gen. engineering.—Address, P501, The Engineer Office. P501 B

DRAUGHTSMAN, Mech., 25 Yrs., REQ. SIT., 4 yrs.' D.O. Exp. Filling mach., telephone and radio det., 5 yrs.' shop exp., gen.—Address, P500, The Engineer Office. P500 B

DRAUGHTSMAN (27) SEEKS POST in London district. Experienced in machine and jig design, 3 years with present firm in Midlands.—Address, P506, The Engineer Office. P506 B

JR. DRAUGHTSMAN, Age 17, REQUIRES SIT.; 6 months' experience in tracing and detailing.
Address, P509, The Engineer Office. P509 B

JR. DRAUGHTSMAN (24) REQUIRES PROG. POST ; 10 years' D.O. and shop exp., design, detail and arrgts. for mech. and struct. eng. Good training and refs. Mod. sal.—Address, P494, The Engineer Office. P494 B

PARTNERSHIPS

WANTED, PARTNERSHIP (Half-share) in Small ELECTRICAL and GENERAL ENGINEERING REPAIRS BUSINESS, Nth. Midland area ; if near running stream an advantage ; invest £200.—Apply, T. ROPER and CO., Bromsgrove. P493 C

MISCELLANEOUS

Amazing 1930 Examination Successes.

A.M.I.C.E.—93%
A.M.I. Mech. E.—95%
A.M.I.E.E.—100%

Other Examinations (including **B.Sc. Matric., G.P.O., A.M.I. Struct. E., City and Guilds, etc., over 90%.**

These magnificent records once again reinforce our position at the head of all Engineering Tutorial organisations.

We are the only Institute that gives a clear-cut guarantee to return full tuition fees to students who fail to pass their Examinations.
Why do not other Institutes offer this straightforward safeguard to their students ?

Because of our extensive organisation and because of the thorough efficiency of our Courses, we can meet your need whether you require a general Civil, Mechanical, Motor, Electrical or Wireless training, special training in some specialised branch, or complete tuition for B.Sc., A.M.I.A.E., A.M.I.C.E., A.M.I. Mech. E., A.M.I.E.E., A.M.I. Struct. E., G.P.O. (Eng. Dept.), City and Guilds, or other technical Examination.

Our Advisory Director, who has devoted a lifetime to his subject, will be happy to advise you on any particular point you may raise. Let us get together. Send to-day for our inspiring handbook "ENGINEERING OPPORTUNITIES," FREE, post free, and without obligation.

The British Institute of Engineering Technology, 22, Shakespeare House, 29-31, Oxford Street, W.1.
D 459 I

DO YOU SEEK A PUBLISHER ? MSS. of all kinds required for immediate publication. Advice, Lists, and Booklets of Commendation free. Established 30 years.—Messrs. STOCKWELL, Ltd., 29, Ludgate-hill, London. 5841 I

FOR HIRE

RICHD. D. BATCHELOR, ARTESIAN WELL ENGINEER (WATER SUPPLIES EXPERT).
Largest Boring, Sinking, and Pumping Plant.
GRAVESEND CORPORATION TESTED TWO BORINGS to 14,000,000 GALLONS PER DAY (ONE GUARANTEED to 7,000,000).
73, Queen Victoria-street, E.C. 4, and Chatham.
'Phones : Central 4908 ; Chatham 2071.
Wires : Boreholes, London ; Watershed, Chatham.
ESTAB. OVER 150 YEARS.

EDUCATIONAL

Correspondence Courses
OF PREPARATION FOR THE
Examinations of the
INST. OF CIVIL ENGINEERS,
INST. OF MECH. ENGRS.,
INST. OF STRUCTURAL ENGRS.,
UNIVERSITY OF LONDON, &c.,
are personally conducted by
Mr. Trevor W. Phillips,
B.Sc., Honours, Engineering, London University, Assoc. M. Inst. C.E., A.M.I. Struct. E., M.R.S.I., F.R.S.A., Chartered Civil Engineer, &c.
For full particulars and advice apply to :—36, DALE-STREET, LIVERPOOL (Tel., Bank 1118). LONDON OFFICE : 65, CHANCERY-LANE, W.C. 2. EX.

THE T.I.G.B.
HAS PLEASURE IN ANNOUNCING
this remarkable record of sustained success
.....
over 90% Passes at the A.M.Inst.C.E., A.M.I.Mech.E., A.M.I.E.E., etc. Examinations held in 1928, 1929 and the first half of 1930.

Proof of the superiority of T.I.G.B. Training, as attested by students' results, is now conclusive and overwhelming. Additional proof is available in the co-operation extended to The T.I.G.B. by various professional examining bodies, trade institutions, and government departments.
The reasons for the high reputation of The T.I.G.B. are, therefore, obvious, and there can be no question that, by enrolling with The T.I.G.B. you make the best choice of training and have the best assurance of success.
WRITE NOW for "THE ENGINEER'S GUIDE TO SUCCESS," 128 pages, containing the widest selection of engineering courses in the world, and mention the post and duties, or the professional qualification, A.M.Inst.C.E., A.M.I.Mech.E., A.M.I.E.E., etc., for which you desire to be trained.

The T.I.G.B. Guarantees Training until Successful.

THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN,
76, Temple Bar House, London, E.C.4.
(*Founded* 1917.)

PATENTS

KING'S PATENT AGENCY, Ltd. (B. T. KING, Regd. Patent Agent G.B., U.S., and Can.). Advice, handbook and consultations on Patents and Trade Marks FREE.—146A, Queen Victoria-street, London, E.C. 4. 43 years' ref. 'Phone : Central 0682. 5839 H

THE OWNERS of BRITISH PATENT No. 331,327, "A Device for Trimming or Cutting the Edges of Lawns and the like," are PREPARED to ENTER into NEGOTIATIONS with manufacturers or interested parties to WORK and EXPLOIT the same on reasonable terms.
Address, P498, The Engineer Office. P498 H

THE PROPRIETOR of BRITISH PATENT No. 229,876, for "Improvements in Power-driven Mechanism for Breaking Pig Iron, Rock or other Material," is DESIROUS of ENTERING into NEGOTIATIONS with interested parties for the GRANTING of LICENCES thereunder on reasonable terms or for the SALE of the PATENT OUTRIGHT.—Communications please address to Messrs. DICKER, POLLAK, and MERCER, Chartered Patent Agents, 20-23, Holborn, London, E.C. 1. 6065 H

THE PROPRIETORS of the PATENT No. 296,748, for "Improvements in or relating to Machines for Forming Wire Articles," are DESIROUS of ENTERING into ARRANGEMENTS by way of LICENCE and OTHERWISE on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country.—All communications should be addressed in the first instance to Haseltine, Lake and Co., 28, Southampton-buildings, Chancery lane, London, W.C.2. 6064 H

THE OWNERS of BRITISH PATENT No. 284,338, relating to "Improvements in or relating to Heat Exchange Apparatus," are DESIROUS of ENTERING into NEGOTIATIONS for the GRANT of LICENCES thereunder on reasonable terms.—For particulars address, F. W. LE TALL, 2, Norfolk-street, Strand, London, W.C. 2. 6052 H

THE PROPRIETORS of BRITISH PATENT No. 302,661, are prepared to SELL the PATENT or to LICENSE BRITISH MANUFACTURERS to work thereunder. It relates to water-tube boilers and similar heat interchangers.—Address, BOULT, WADE and TENNANT, 112, Hatton-garden, London, E.C. 1. 6058 H

THE PROPRIETOR of BRITISH PATENT No. 242,501, dated March 9th, 1925, relating to "Improvements in Couplings for Tubular Rods," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or OTHERWISE on reasonable terms for the purpose of exploiting the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois. 6059 H

THE PROPRIETOR of BRITISH PATENTS Nos. 275,085 and 284,078 is PREPARED to SELL the PATENTS or to LICENCE British Manufacturers to work thereunder. They relate to laminated molds for use in pulp-moulding machines.—Address : BOULT, WADE and TENNANT, 112, Hatton-garden, London, E.C. 1. 6077 H

For continuation of Small Advertisements see page 4.

Gears
See large advertisement next week.
The Power Plant Co. Ltd.
WEST DRAYTON · MIDDLESEX

LOCOMOTIVE MARINE STATIONARY
"M.L.S."
SUPERHEATERS
To suit all requirements.
Specialists in Design and Manufacture
The **SUPERHEATER**
COMPANY LIMITED
BUSH HOUSE, ALDWYCH, W.C. 2.
335 A

A Seven-Day Journal

The Cutlers' Feast.

On Thursday, November 6th, the Cutlers' Feast was celebrated in the Company's Hall, Sheffield, with the customary dignity. Mr. Peter Boswell Brown is the Master Cutler. He occupied the chair and made an admirable host to a very large party. The principal guests of the evening were Admiral Sir Roger Keyes; Mr. Tom Shaw, Minister for War, and Mr. R. B. Bennett, Prime Minister of Canada, who, only that afternoon, had been presented with the Freedom of the City. The first toast at the Feast, is, by tradition, that of "The Imperial Forces," and the response is left in the hands of a representative of each of the great forces in turn. This year Admiral Sir Roger Keyes responded for the Navy. In proposing the toast, the Senior Warden, Mr. Joseph Ward, said that Sir Roger's name would go down to posterity in connection with the attack on Zeebrugge which he directed. The Admiral, in his reply, claimed that maritime commerce was as vital to the people of the Empire as the air they breathed, and that prosperity, security and peace followed in the wake of sea-power. Councillor Arthur Neal gave the toast of "His Majesty's Ministers," which was acknowledged by Mr. Tom Shaw, who dealt at some length with the problem of unemployment. After asserting that we have capital in abundance, he went on to say that he accepted the view that our methods of currency and commerce have not kept pace with developments in production, and that we have literally a state of things in which capital and labour are frozen fast and cannot move for want of a sufficient medium of exchange. He did not see the cure for the present conditions. The Government was not composed of magicians, and all that could be done was to be tireless in looking for remedies. The toast of "The Empire Overseas," proposed by Mr. R. W. Matthews, gave Mr. Bennett the opportunity for a stirring reply. He spoke of the bonds between the Mother Country and the Dominions, and the great Empire problem of the day. "It," he said, "far transcended politics, far transcended parties and individuals; it touched the life of a quarter of the world's people, it touched civilisation itself." There was always a danger of unity being replaced by separation. That must not be allowed to happen; it was each for all and all for each. Only in that spirit would the Empire advance to the solution desired. The Feast concluded with the toast of "The Master Cutler," proposed by the Lord Mayor and most enthusiastically received by the great gathering.

Wages Reduction in Germany.

The Arbitration Commission in Germany has confirmed the wages reduction in the engineering industries. This step may eventually lead to important consequences as regards competition in foreign markets. The first Government award reducing wages from 6 to 8 per cent. was repudiated by the men, who, nevertheless, agreed to accept the ruling of an independent commission of three presided over by a former Minister of Labour. A unanimous decision of this body has now confirmed the former award except that the wages reduction will be spread over two months. There will be a first reduction of 3 per cent. from November 17th, and another of 3 per cent. from January 19th for men under 18 years of age, and of 5 per cent. for the others. This progressive application of lower wages is made in the hope that it will bring about an adjustment of living costs to the new scale during the period that wages are being lowered, instead of remaining probably for some time at the present level in the event of the whole reduction being imposed at once. The object of the wages reduction is, of course, to bring down selling prices, and it was expected that the award would be accompanied by some definite agreement fixing the relation of selling prices to wages, but the arbitrators declare that it is quite impossible to settle relative values of that kind. There is, they say, every reason to believe that the inevitable cut in wages will be accompanied by lower costs all round. If this movement in Germany for a reduction of wages and costs should prove effective, it will necessarily spread to other nations on the Continent.

Frequency Standardisation.

In a paper read a few days ago by Mr. F. H. Mann before the Birmingham Association of Mechanical Engineers, the impending change in the frequency of the supply of alternating current in the Birmingham area was discussed, and it was pointed out that advantage would be taken of the change to raise the voltage from 5000 to 11,000, in order to render the transmission and distribution of high-tension current more efficient and economical. The change over, Mr. Mann explained, would be undertaken in the outlying districts of the city area as soon as a 50-cycle supply at 11,000 volts was available from the National Grid sub-stations, and it would be gradually extended towards the central area, which would be the last to be dealt with. In all probability the change over would be complete within seven or eight years. The change over, he explained, afforded the consumer a unique opportunity to revise his electrical plant, with a view to obtaining increased efficiency and economy. Under the scheme approved by the Central Electricity Board, it was open to any consumer to agree with the electricity department on a lump sum to cover the entire cost of the change over, and to arrange himself for the design and execution of the work. The method allowed considerable flexibility and made it possible for the consumer, while the change over was being effected, to carry out such modifications in his plant as would secure improved working results. Careful consideration would have to be given to the selection of the 50-cycle plant to be substituted for the 25-cycle plant, so as to secure the utmost benefit from the change over.

The New Pretoria Steelworks.

On Friday of last week, November 7th, the South African Steel and Iron Industrial Corporation, Ltd., announced the names of the firms which had successfully tendered for the construction of the new steel works at Pretoria. For the steel melting shop and rolling mills, Dorman, Long and Co., Ltd., of Middlesbrough, tendered jointly with the German firm of Demag. The whole of the steel work for fabrication in South Africa, involving a weight of steel of some 15,000 tons, will be manufactured at the Middlesbrough works of Dorman, Long and Co., Ltd., while the Demag A.G. will probably supply the steel furnaces and two rolling mills. The blast-furnace plant, which will be constructed according to the designs of the Freyn Engineering Corporation, of Chicago, will be built by Ashmore, Benson, Pease and Co., Ltd., of Stockton-on-Tees, and the coking and by-product plant will be made in Great Britain by Woodhall, Duckham and Co., Ltd. It is understood that a very large number of firms tendered for the work, and that international competition was keen. Pretoria has been selected as the site on account of the close proximity of supplies of both coal and iron ore. The capacity of the blast-furnaces will be 500 tons of iron per day, and there are to be two 100-ton steel furnaces, each designed to deal with 300 tons per day, in conjunction with a 400-ton metal mixer. The contracts are to be signed in South Africa in about five weeks' time, and it is understood that work will be begun at the earliest possible moment. It is hoped that the works will be in full production in about three years' time, when it is estimated that they will give employment to between 1500 and 1700 men, including the technical staffs of the different departments.

Motors and Locomotives.

It was reported about a month ago that the directors of Halley Motors, Ltd., of Yoker, Glasgow, had received an offer from the directors of a certain company for the purchase of a controlling interest in the Halley Company's business. It was officially announced this week that the company making the offer was the North British Locomotive Company, Ltd., of Glasgow. The agreement which has been entered into covers the purchase of 50 per cent. of the Halley Company's 6s. 8d. ordinary shares at 2s. per share and 50 per cent. of the £1 preference shares at 4s. each. A sufficient number of the Halley Company's shareholders have offered to dispose of their shares to enable the transaction to be carried through. The North British Locomotive Company, Ltd., has an issued capital of £750,000 in cumulative preference shares and £1,250,000 in ordinary shares. The Halley Company's capital consists of £49,801 in cumulative preference shares and £115,514 in ordinary shares. Except during the war period when it manufactured tanks, shells and other munitions, the North British Locomotive Company, Ltd., has in the past confined its activities to the production of locomotives, although in earlier days its constituents—Neilson and Co. (Neilson, Reid and Co.), Sharp, Stewart and Co., and Dübs and Co.—manufactured between them marine engines, machine tools, and other engineering products, besides locomotives.

Rationalisation in Shipyards.

Early last week the shipbuilding activities of William Beardmore and Co., Ltd., of Dalmuir, came to a close with the launch of the steamer "Pole Star" for the Northern Lighthouse Commissioners. At that launch the chairman of William Beardmore and Co., Ltd., Mr. H. A. Reincke, made appropriate reference to the closing of the shipyard, and emphasised the fact that the firm would concentrate all its energies on the forging, marine engineering, locomotive building and high-speed oil engine sides of its business. At a dinner of the Foremen's Mutual Benefit Society held in Glasgow on Saturday last, Sir James Lithgow, the chairman of National Shipbuilding Securities, Ltd., made a reference to the recent acquisition of Messrs. Beardmore's yard by his company, and stated that negotiations were proceeding with two further shipbuilding companies on the Clyde and one on the North-East Coast with a view to eliminating redundant shipbuilding capacity. He repudiated the suggestion that it was the intention of his company to reduce the shipbuilding capacity on the Clyde without reference to that of the other shipbuilding centres in Great Britain. On Tuesday, November 11th, members of the Shipbuilding Employers' Federation, along with representatives of National Shipbuilding Securities, Ltd., met shipyard trade union representatives in London to discuss the possible claims of displaced workers. Sir James Lithgow explained the reasons for the new "concentration company," and gave an assurance that the shipbuilders associated with the company believed that the elimination of redundant capacity would not mean less employment. The reduction of capacity, he said, would not be done in any haphazard way, and the transference of labour between districts would be minimised as far as possible. Mr. A. L. Ayre, the new President of the Shipbuilding Employers' Federation, dealt with the outlook in the industry, and supported Sir James Lithgow's views. In the discussion which followed there was a frank interchange of views on the present position of the industry. The union representatives, however, while appreciating the information given by the employers, reiterated their intention of pressing claims for the compensation of displaced workmen, and it seems likely that another conference will be held later on.

The R 101 Inquiry.

After sitting continuously — Saturdays and Sundays excepted—since October 28th, the public court of inquiry into the loss of "R 101" was adjourned on Monday, November 10th, until December 3rd. In announcing the adjournment, Sir John Simon said that so far they had been seeking to establish the facts of the disaster. The resumed sittings would be devoted to an endeavour to elicit the cause. It had been established, he said, that the airship had been flying at a reasonable height, that she got into a rather severe dive, and that for a few seconds she was pulled up again to the horizontal. Before that period had elapsed someone in the control car had been able to send a message to the effect that the airship was coming down. The vessel then took a second dive and crashed. It ought, Sir John continued, to be possible to make a list of causes which might have led to the disaster, and then by eliminating those which could be said with confidence not to have been in action, to arrive at the true cause. Among possible causes mentioned by Sir John by way of example was foolish navigation, such as putting the elevator down when it should be up. That cause, he added, was possible, but very improbable. Another cause would be the breaking of the ship in the air. A third was a meteorological cause, such as that the ship met a meteor. By the word "meteor," Sir John is to be understood as meaning any unusual phenomenon in the air, and not a meteor in the limited popular sense. In the interval of the adjournment, Professor Bairstow will conduct a scientific investigation suggested during the course of the inquiry, presumably on the stability of an airship while suffering a progressive leakage of gas.

The Engineering Unions and the Government.

Many months ago the thirty-odd trades unions connected with the engineering industry submitted a claim to the employers for an advance in wages of 8s. per week for time workers and corresponding increases for piece workers. The employers refused the claim. The unions suggested arbitration. The employers proposed that before taking the claim to arbitration they and the unions should jointly investigate the working conditions and costs of manufacture on the Continent. The unions rejected this suggestion, and appealed to the Government to institute an official inquiry into the state of the engineering industry. The Government received a deputation on the subject from the unions and later heard the views of the Engineering Employers' Federation. It decided against the unions' wish for the establishment of a governmental inquiry on the grounds that the engineering industry, unlike the iron and steel and the cotton industries, in connection with which official inquiries had been held, was not one, but many industries, each of which would require a separate inquiry. Moreover, the proposed inquiry would occupy a very long time, during which the functioning of the ordinary negotiating machinery would be affected. The Government also argued that the inquiries in connection with the iron and steel and the cotton industries were not of the same character as the suggested inquiry in connection with the engineering industry, in that they did not arise out of wages negotiations. While it decided against an official inquiry, the Government suggested that the employers and the unions should themselves jointly investigate the circumstances and problems of the engineering industry, and offered to place certain resources of the various Departments at the disposal of the investigating committee. On Thursday of last week, November 6th, the Executive Committee of the unions met in London to consider the Government's reply. It decided to reject the suggestion for a joint investigation, as it was substantially the same proposal as that previously advanced by the employers. The meeting resolved to remit the question of future policy concerning the wages claim to the individual Executive Committees for separate consideration.

The Heating and Drying of Granular Materials by Convection.

By W. GILBERT, Wh. Sc., M. Inst. C.E.

No. II.*

Coal Drying: Representative Experiments.

Some representative experiments on coal drying may now be described and illustrated by various graphs. The grades mainly used were III., V., VII., and IX. The average lump size in each grade is

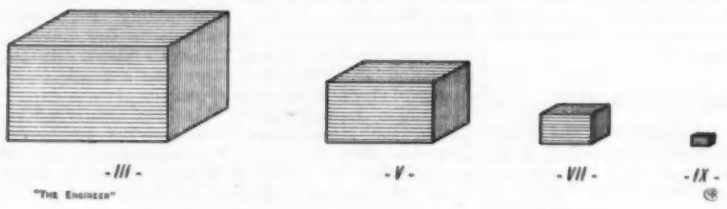


Fig. 8—Average Lump Sizes of Coal Samples

fairly well represented by the rectangular blocks shown full size in isometric projection in Fig. 8.

Previous to the velocity experiments and for the sake of comparison tests were made on coal drying in small furnaces under conditions where W = 0.

G.B.L. IX. coal when spread out on a thick iron plate which formed the base of a small muffle furnace—see Fig. 10. Here A is the iron plate, B a mercury thermometer placed horizontally, and C indicates three Fletcher-Russell safety gas burners arranged longitudinally. The coal was heated directly by the plate and also by the walls and roof of the fire-brick chamber in which the plate was enclosed. The area of the iron plate was 15 square inches, and of this space the coal, as evenly spread out, occupied 7 square inches. The upper and lower surfaces of the particles would be exposed to full radiation, but the sides and ends might be partly screened by adjacent particles, although there was no contact between them. The furnace and plate temperature ranged from 304 deg. to 316 deg. Fah., considerable difficulty being experienced in keeping the temperature of a gas-fired furnace of this type steady at low temperatures.

Further details of the furnace drying experiments are given in Table IV.

Column (10) gives the total rate of heat transmission H as obtained from an analysis of the graphs. In each case H is the mean value estimated over the period during which the average coal temperature

Table IV.—*Experiments with Furnace Drying.*

Graph letter.	Class and grade of coal.	Weight of charge, dry grammes.	Surface of charge, square inches.	Furnace used.	On plate or on grid.	Time to dry out 90% of moisture, mins.	H_c	H_r	H ($H_c + H_r$)
A	D.N. III.	4·20	2·32	Copper	Grid	41·0	0·59	2·83	3·42
B	G.B.L. VII.	1·97	4·45	Copper	Grid	8·1	—	2·65	2·65
C	G.B.L. IX.	3·34	27·8	Muffle	Plate	2·0	0·31	2·80	3·11
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)

H_c = Heat transfer by convection per square foot of coal surface per hour per deg. Fah. temperature difference (furnace wall and coal surface temperature). H_r = heat transfer by radiation per square foot of coal surface per hour per deg. Fah. temperature difference (furnace wall and coal surface temperature).

Graph A, Fig. 9, illustrates the drying of a single lump of D.N. III. coal in the copper furnace—refer Fig. 6 *ante*. The lump was supported above the floor on a tripod of fine iron wire, so that practically the whole of its surface was exposed to the hot air and to the radiated heat from the furnace walls. The interior of the furnace was coated with lampblack throughout to secure black body radiation. A steady furnace temperature of 320 deg. Fah. was maintained. The lower curve on the graph shows the quantity of moisture evaporated after any period of drying. The evaporation is expressed as a percentage of the initial moisture in the coal. The upper curve gives the average temperature of the coal lump and the contained water after any period of drying, as determined by a water calorimeter.

It will be seen that after drying for forty-one minutes the evaporation was 90 per cent. of the water originally present in the coal, and the average coal temperature had risen to within two or three degrees of the furnace temperature.

Graph B, Fig. 9, illustrates the drying of a few lumps of G.B.L. VII. coal in the copper furnace. The lumps were supported on a grid of wide mesh and of very fine wire, and were thus fully exposed to radiation and convection, the conditions being similar to those of graph A.

Graph C, Fig. 9, illustrates the drying of a charge of

rises by 95 per cent. of the total. The total rise = furnace temperature − initial coal temperature.

Column (9) shows the proportion of heat which would be transmitted by radiation using a coefficient of 1·6 in the formula, and column (8) shows the rate of heat transfer by convection, this being obtained by difference. The air in the furnace presumably takes up an intermediate temperature, since it abstracts heat from the furnace walls and transfers it to the coal. In calculating the values of H and H_c the full temperature difference between the coal surface and the furnace walls at any instant is used. Hence the real values of H_c are greater than those given in column (8).

For graph C the value of H_c in column (8) reached 9·7 over the first quarter minute, but this value was not maintained throughout the heating period.

To calculate the surface temperature of the coal at any instant a value for the conductivity of 1·42 has been used. In furnace drying, after the prolonged heating which is required to eliminate the moisture, it may be that the conductivity is reduced. In this event the average values of H_c which are reckoned over a large part of the drying period will be too low.

A similar result was obtained when drying lumps of larger size on the hot plate. Values of H_c = 5 to 6 were obtained by an analysis of the early portion of the curves, but such values were not maintained throughout. The average value of H_c, after allowing for radiation, ranged from 0·1 to 0·3; hence, when coal is dried on a hot plate in a hot enclosure, apparently the drying takes place mainly by radiation.

If the coal lumps are packed closely together on the hot plate the full surface is not available to receive radiation, and the rate of drying of individual lumps should be proportionately decreased.

Experiments with Velocity Apparatus.

A selection of these experiments on coal drying is illustrated by the graphs D, E, F, G, H, I, J, and K, Figs. 11 and 12. The values of W used for each grade were 400, 1600, 2800, and 4000; but, for reasons of space, the experiments made at 1600 and 4000 are omitted. As previously mentioned, W is used to denote the weight of air passing through the outlet bush of the drying apparatus in pounds per square foot of cross section per hour.

Compared with furnace drying, the marked increase in the rate of drying, especially in the case of the smaller grades, will be noted. Further details of these experiments are given in Table V.

Graph D illustrates the drying of D.N. III. coal at W = 400.

The hot air temperature at the drying grid, marked a T on the graphs, was 400 deg. Fah. in all cases. In these experiments the coal lumps were heated by convection, but cooled by radiation to the water-jacketed outlet bush, and to the surroundings of the laboratory, the average temperature to which the coal radiated being 78 deg. Fah. Under these conditions, at the end of a drying experiment, the average temperature of the coal did not tend to approach 400 deg. Fah., but approximated to a lower value

Table V.—*Drying with Velocity Apparatus.*

Graph letter.	Class and grade of coal.	Initial moisture per cent.	Surface of coal, sq. ft. per dry lb.	Value of W.	Time to dry out 90% of moisture, mins.	H_c. Initial value.
D	D.N. III.	6·65	1·70	400	29·6	4·82
E	D.N. III.	7·11	1·81	2800	10·3	14·30
F	D.N. V.	7·21	2·87	400	12·8	6·25
G	D.N. V.	7·45	2·87	2800	4·5	15·90
H	G.B.L. VII.	13·18	7·10	400	3·10	10·2
I	G.B.L. VII.	14·11	7·10	2800	1·38	26·0
J	G.B.L. IX.	14·72	26·20	400	0·70	15·5
K	G.B.L. IX.	15·36	26·20	2800	0·23	53·0
(1)	(2)	(3)	(4)	(5)	(6)	(7)

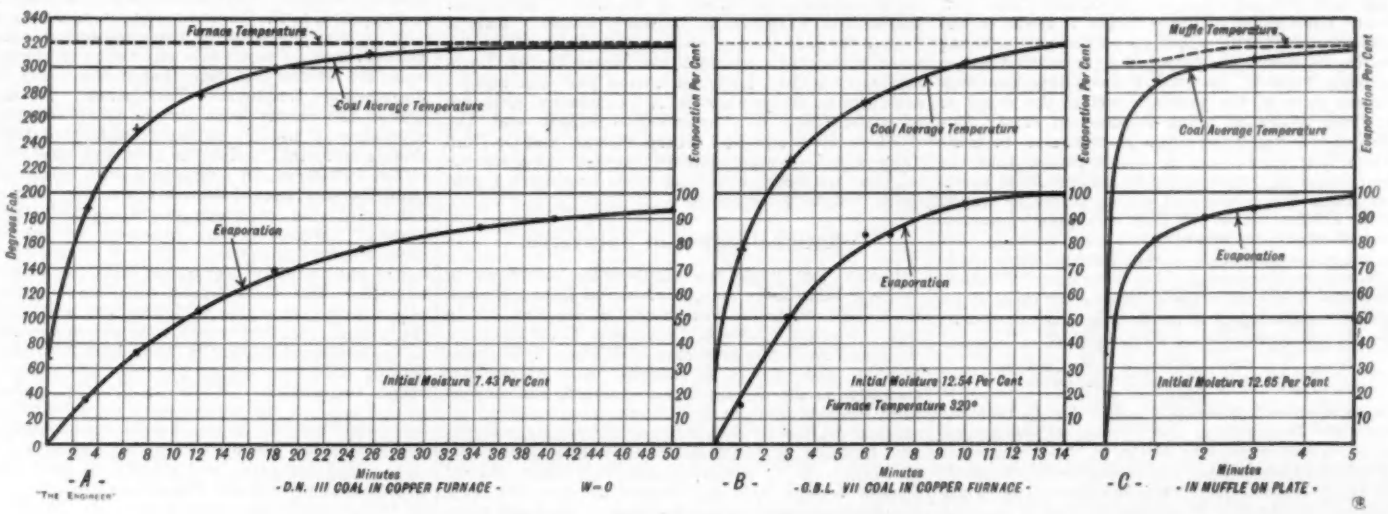


Fig. 9—Graphs Illustrating the Drying of Coal

Hence, if the final temperature of the coal lump can be measured with sufficient accuracy, a method of obtaining the rate of heat supply by convection to a coal lump over a wide range of sizes, air velocities and temperatures is thus available. Experiment showed, however, that the value of H_c was not constant

* No. I. appeared November 7th.

throughout the drying period, but became a maximum when the coal was completely dry.

Graph E illustrates the drying of D.N. III. coal for

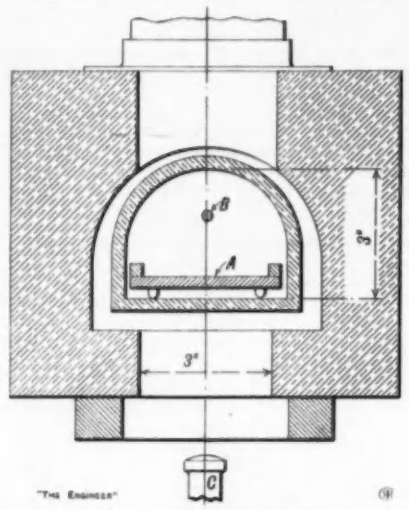


FIG. 10—MUFFLE FURNACE

W=2800. The rapid increase in the rate of drying, as the lump or particle size is reduced, will be noticed. Thus, in the case of graphs J and K the time base is divided into seconds instead of minutes. The same feature is illustrated by column (6) of Table V., which should be compared with the figures in column (7) of Table IV. The values of H_c in column (8) represent the rate of heat supply to the coal lumps by convection per square foot of coal surface per hour per degree Fahrenheit temperature difference. The temperature difference is that between the hot air, 400 deg. Fah., and the average surface temperature of the coal. A suitable deduction is made for the loss of heat by radiation and for the fall of hot air temperature on passing the lumps. The figures in column (7) are deduced from the early part of each graph, and in the case of velocity drying are less subject to experimental errors than values obtained from later periods on the graphs. The method by which values of H_c are duduced from the coal drying graphs will be explained later.

Effect of Moisture in Coal.

It will be noticed that the D.N. coal only held initially about half the moisture of the G.B.L. coal. The actual moisture percentage, however, has little effect on the rate of drying. With a relatively dry coal, the average temperature curve rises more quickly, thus reducing the effective temperature difference between the hot air and the coal.

Method of Experimenting.

The methods adopted both as regards furnace drying and drying by the velocity apparatus were generally similar, but the following description applies to the velocity apparatus. The evaporation curve on the graphs was first obtained. The coal was taken from soak and centrifuged, a suitable quantity was then weighed out and placed on the grid of the drying apparatus—Fig. 3 *ante*—which was removed for the purpose. The grid was quickly replaced, and the coal heated for a definite period, such as 5 minutes, the time being measured by a stop watch. At the end of the period the grid was quickly removed, and the charge re-weighed on a chemical balance to obtain the loss of moisture. Finally, the sample was completely dried in a furnace in order to determine the weight of water originally present in the coal. The process was repeated, with fresh samples of coal, for a number of drying periods, and the evaporation curve eventually obtained.

To obtain the curve of coal average temperature, a second set of experiments was made, and for the same heating periods. At the end of each heating period the coal was quickly tipped from the grid into a water calorimeter, and the rise of temperature noted. Finally, the coal was separated from the water and dried, and the dry weight of the sample obtained. Since the coal was weighed before drying, the initial moisture in the coal was obtained by difference, and it was assumed that the percentage evaporation, after any period of drying, in the repeat experiment, could be taken from the evaporation curve previously obtained. Hence, the sample, as tipped to the calorimeter, was known to contain A grammes of dry coal (specific heat=0·33) and B grammes of water (specific heat=1), and from these data the average coal temperature could be obtained.

Water Calorimeter.

The calorimeter used is shown in Fig. 15. A copper vessel B containing 500 c.c. of water is enclosed in wooden box A, leaving about 2in. air space all round. The inside of the box is lined with bright tin sheets. Using a funnel, the coal was tipped into the copper vessel, through a hole of 1½in. diameter in the lid, the hole being normally closed by a wood plug G.

The coal tipped into the calorimeter fell on to a tray of 20-mesh sieve, marked E, which could be moved up and down through the water by the rod F. The temperature rise was observed by a mercury thermometer C, carried in wire supports D. The thermometer was divided into one-tenth degrees Fah. The tray of sieve wire was suitably recessed to clear the thermometer and supports.

To throw some light on the temperature distribution inside a lump of granular material during heating by convection, graph L, Fig. 16, has been prepared by the aid of the Fourier Equation of Heat Conduction. It illustrates the heating of a lump of material of 1in. cube, which is placed in a hot air stream of temperature 644 deg. Fah. No account is taken of radiation. The following particulars relate to the graph :—

H_c	16·26
Conductivity of material in B.Th.U. per square foot per hour, per inch thick, per deg. Fah. tem. diff.	1·5
Density in lb. per cubic foot	81·6
Specific heat	0·33
Initial temperature of cube	75 deg. Fah.
Final " "	644 deg. Fah.

On the graph the cube average temperature after any period of heating, is denoted by the curve A B C, which shows, for instance, that the average temperature rose to 477 deg. Fah. after 4 minutes of heating. A D E is the curve of average surface temperature. The surface temperature is not evenly distributed over the surface of any face, but is greatest at the corners. A F G is the temperature at the centre of the cube.

During the first two or three minutes the calculated temperature at the centre of the cube is uncertain, owing to the difficulty of taking sufficient terms of the Fourier series.

Consider the ordinate at 4 minutes K B D H, then B D is the difference between the cube average temperature and the mean surface temperature, and approximately represents the temperature difference available for passing heat into the block. H D is the temperature difference between the average surface temperature of the block and the hot air.

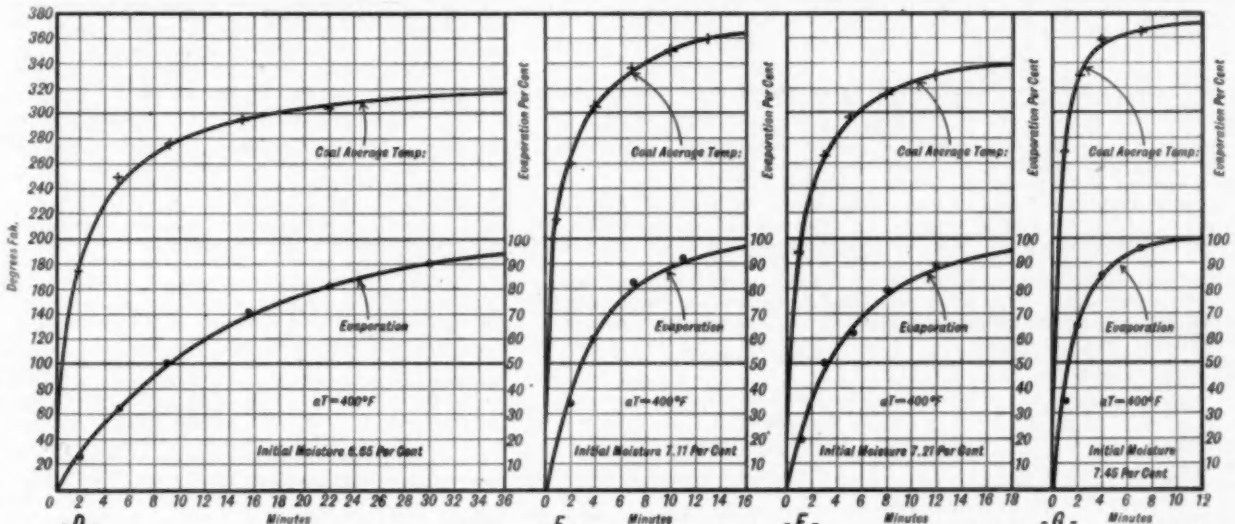


FIG. 11—GRAPHS ILLUSTRATING THE DRYING OF COAL

Suppose it is required to deduce the value of H_c from the average temperature curve at the ordinate K B D H, the surface temperature being known, the procedure is as follows :—Taking the period from three to five minutes, the rise of the cube average temperature is 514−428=86 deg. Fah., and the rate

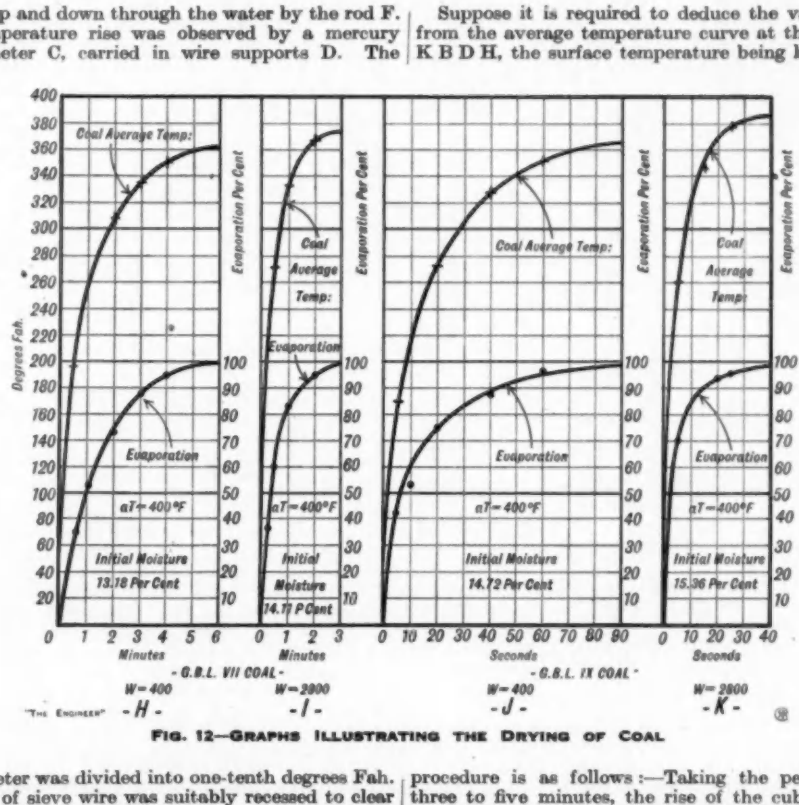


FIG. 12—GRAPHS ILLUSTRATING THE DRYING OF COAL

per hour at which heat is being supplied to the block is

$$\frac{1}{1728} \times 81 \times 0{\cdot}33 \times 86 \times \frac{60}{2} = 39{\cdot}9 \text{ B.Th.U.}$$

Now, the surface of the block is 6 square inches, and the temperature difference H D = (644 − 585) = 59 deg. Fah., hence

$$H_c \times \frac{6}{144} \times 59 = 39{\cdot}9$$

and

$$H_c = \frac{39{\cdot}9 \times 144}{6 \times 59} = 16{\cdot}26$$

which is correct.

In the experiments previously described, A B C represents the average temperature curve which is determined in each case experimentally by the water calorimeter, and the object of the preceding calculation is to bring out the fact that in order to deduce the value of H_c at any point of the average temperature curve, the surface temperature curve must also be known.

Several attempts were made to measure directly the surface temperature of the coal lumps during the heating process, but without success; hence, indirect methods had to be finally used.

Referring again to graph L, if the 1in. cube of material had been composed of copper, the conductivity would be 2630 instead of 1·5—which is the approximate value for coal in lump form—and under the same conditions of heating, the length D B at 4 minutes would, roughly speaking, be reduced in the ratio $\frac{1{\cdot}5}{2630}$, that is D B would be less than one-tenth of a degree Fahrenheit. Hence, in the case of a copper cube, the surface temperature curve would coincide with the average temperature curve.

In the drying experiments, therefore, if the lumps of the various grades had been composed of copper, instead of coal, the value of H_c could be deduced at any point of the average temperature curves by a simple calculation such as that made for the 1in. cube.

Accordingly, in the case of D.N. III. coal—the experiments on which are illustrated by graphs A, D, and F, Figs. 9 and 11—lumps were made in copper of the same size and shape as the coal lumps, and the surface was chipped to imitate the coal surface. The copper blocks were coated with lampblack, in order to make their radiating power equal to that of coal. They were then heated on the grid, under the same conditions as the coal lumps, and the curve of average temperature obtained by using the water calorimeter.

The values of H_c as deduced from the average temperature curves for W = 400, 1600, and 2800 are plotted against the copper block temperature on graph M, Fig. 13.

Values of H_c, as shown on the lower portion of the curves on graph M, Fig. 13, for W = 400 and W = 2800 should, of course, be obtained from the experiments on D.N. III. coal—see Table V., column (7). The difference is not large.

It will be noticed that the value of H_c is not constant throughout the heating range for each value of W, but after a time it increases as the block temperature rises, and as the temperature difference between the hot air and the copper block is reduced.

For copper block temperatures below, say, 160 deg. Fah., the heat loss by radiation to the water jacket or to the atmosphere would be small, H_r being about 1·2, and the temperature difference also small, so that an error in the constant used with Stefan's radiation law would only have a small effect on the calculated value of H_c. Hence, the lower portion of the curves on graph M may be correct. At the upper end of the curves the heat gained by convection balances the heat lost by radiation. Hence, if the radiation is over-estimated, the value derived for H_c is similarly too large.

Fourteen small copper blocks, approximately 0·34in. by 0·20in. by 0·11in., were also made to represent G.B.L. VII. coal. They were coated with lampblack. When placed on the drying grid of 3½in. diameter, they occupied about one-tenth of the area. Hence, the shielding of one block by its neighbours, as regards heat loss by radiation, would probably be small.

Using a hot air temperature of 400 deg. Fah. as before, average temperature curves were obtained for W = 400 and W = 1600.

The deduced values of H_c, after allowing for radiation loss, are shown on graph N, Fig. 13.

The reason for the increased values of H_c at the upper ends of the curves is not apparent. The values of H_c are based on the difference between the surface temperature of the material and the average temperature of all the air passing the grid, but the temperature of the air immediately in contact with any lump may be less than the average, on account of the heat imparted to the latter and to the low conductivity of air. Hence, the real values of H_c may be more than those calculated by the method described above.

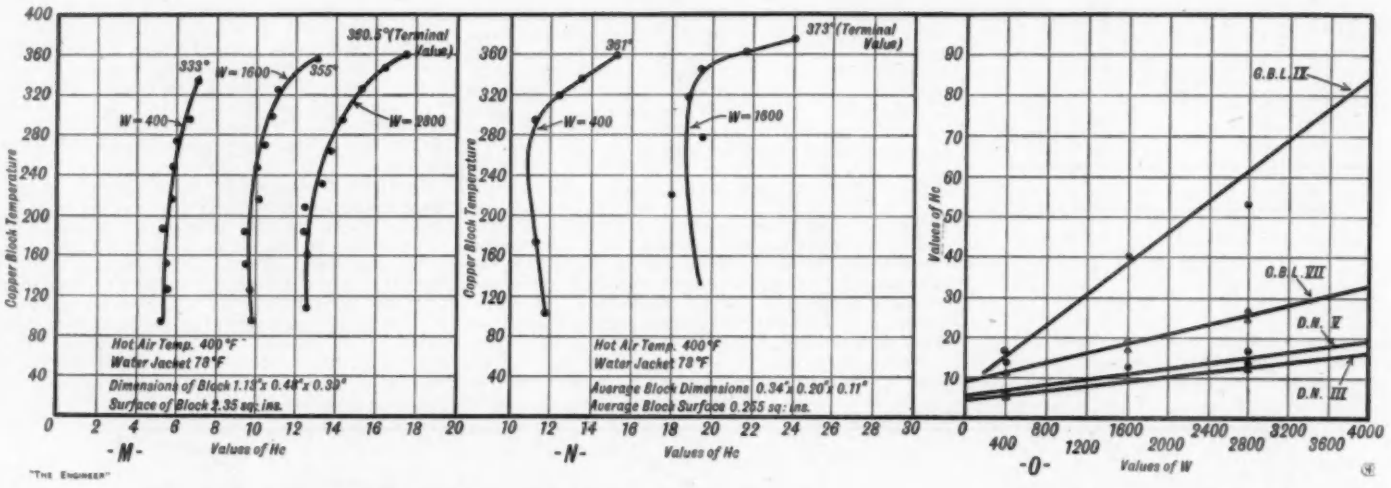


FIG. 13—GRAPHS ILLUSTRATING EXPERIMENTS WITH COPPER BLOCKS

FIG. 14—VALUES OF H_c FOR COAL

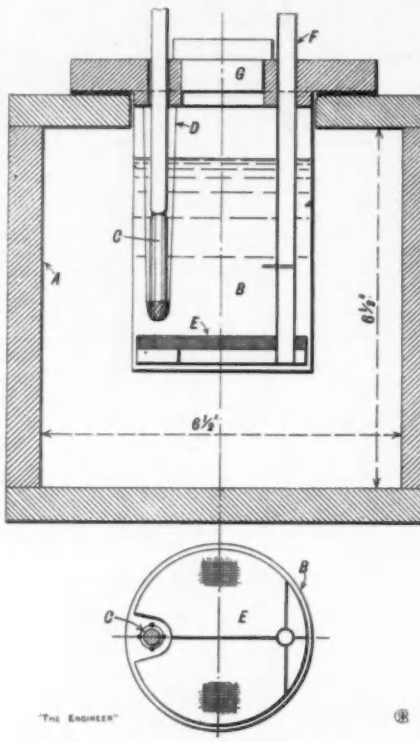


FIG. 15—CALORIMETER

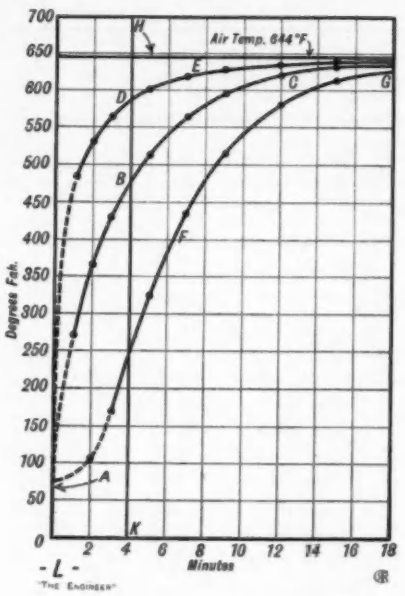


FIG. 16—GRANULAR MATERIAL

Some explanation, which may be on the above lines, is required of the rapid increase in the value of H_c as the particle size is reduced.

The graphs show generally the great advantage of drying in a current of hot air as compared with furnace drying. In the former case, far greater values of H_c are obtained, also the total surface area of all the lumps is available to receive heat. In furnace drying, the quantity of heat transferred is limited by the relatively small area of the fire-brick, or iron surfaces from which heat is usually received.

The graphs give a large amount of useful information without any mathematical analysis in detail, but the values of H_c are calculated because in this way formulæ can be evolved which will give the rate at which materials can be dried or heated under a wide range of conditions not covered by the experiments actually made.

Values of H_c which have been obtained from the early portions of the graphs relating to the velocity experiments, and which are considered to be representative, are gathered together on graph O, Fig. 14. Values of W for the four grades of coal mainly experimented upon are plotted against the corresponding values of H_c.

The Machinery of the Earth.*

By Professor J. W. GREGORY, LL.D., D.Sc., F.R.S.*

A DEFINITION of the word "machine" given in "The New English Dictionary" is "a combination of parts moving mechanically, as contrasted with a being having life, consciousness, and will." According to that definition, the whole earth may be regarded as a machine, as it consists of a combination of various parts, and it is moving through space and revolving round its axis in mechanical obedience to the major forces of the universe and without any conscious impulse or free will of its own.

The study of the primary machinery of the earth involves consideration of its construction and its movements, and especially of those movements of its parts which control its main function—the preparation and maintenance of its surface as the home of man. The secondary machinery of the earth includes the ordinary geographical and geological agencies which control the development of its surface features.

The selection of this definition of a machine as the most appropriate to the earth may appear to an audience of engineers unfortunate, as of the many definitions it is the least mathematical. That is to me its recommendation, as the structure and development of the earth depend on factors that appear too incalculable and indefinite to be settled mathematically. The subject how the earth has worked in the past may be approached along a physical and mathematical path; but as a geologist I naturally place my trust in the direct contemporary evidence of the rocks, the interpretation of which is the function of geology.

* The Institution of Mechanical Engineers. The Seventeenth Thomas Hawksley Lecture, November 7th, 1930. Abridged.

The Structure of the Earth.—The geological method has the great drawback that it can only be applied directly to a thin layer, which is only about one five-hundredth of the radius of the earth; and this restriction to a thin outer shell is the more regrettable as it has long been known that the material of the interior of the earth is different from that of the surface crust which we know by personal experience. The extent of this difference was revealed by Sir Isaac Newton, whose estimate was relatively accurate, as he calculated that the specific gravity of the earth is between 5 and 6. The latest determinations are between 5·5 and 5·8, except that of 5·13 by E. D. Preston (1895). The most probable amount is between 5·5 and 5·6 and the figure generally accepted is 5·53.

Ordinary rocks vary in specific gravity between 1·8 of clay, and 2·2 of sandstone, and 3·0 of basalt. The average cannot be more than about 2·5. For the whole rocky crust or lithosphere, which includes a great thickness of the deeper basic igneous rocks, the average specific gravity is taken by Tyrrell as 2·7. Hence the earth as a whole is composed of material more than twice as heavy as that of the crust. The internal mass is therefore appropriately named the barysphere, and a large amount of its material must have a specific gravity four times as high as that of the rocks of the upper crust. It has been suggested that the matter in the interior owes its high density to compression. Sir A. S. Eddington, in the Fifteenth Thomas Hawksley Lecture, referred to matter which has acquired by condensation a specific gravity of 60,000; hence it would appear easy to quadruple that of terrestrial matter by compression. Nevertheless, the view that the earth consists throughout of the same material of which that in the interior has been heavily condensed by compression has been abandoned. It seems to be universally agreed that the high specific gravity of the interior is due to its containing a high proportion of heavy metals. The density of the barysphere is due to segregation and not to compression, which doubtless raises it to some slight extent.

The high average specific gravity of the earth can be accounted for by a metallic core with a specific gravity of about 8 to 10, or, according to other estimates, as high as 12. The weight could be explained by a smaller mass of heavier metals; but the more probable view is that the high density of the earth is due to a large core which is not, on the average, much heavier than iron. The material is probably mainly metallic iron alloyed with nickel, and containing smaller proportions of other metals and various silicates.

The composition of the barysphere is revealed by several lines of evidence. We may expect the earth to consist of the same materials as other heavenly bodies; and the most positive information as to the nature of extra-terrestrial material is given by those samples of it which fall upon the earth from outer space. They are known as meteorites and are most familiar to us as shooting stars, which are doubtless meteorites that are rendered incandescent by friction during their passage through the air. Their numbers are enormous. Any quick-sighted observer on a dark cloudless night can see about seven in the hour. It is calculated from that fact that from 10 to 20 millions enter the earth's atmosphere every day. The meteorites are shattered into fragments which fall in lumps or dust upon the surface. They are divided into two main classes. The iron meteorites or siderites consist of metallic iron with usually from 7 to 15 per cent. of nickel—the amount ranges from 3 to 41 per cent.—and small proportions of other metals and some silicates. The second class are the aerolites or stony meteorites, which consist mainly of silicates and of mineral species, especially olivine and bronzite, common in the basic rocks of the earth's crust. A small intermediate group, the stony-iron meteorites or siderolites, including the pallasites, consists of nickel iron and silicates.

The proportion of the iron and stony meteorites may be estimated from various data. Sir Lazarus Fletcher's list of the meteorites in the British Museum in 1904 shows that the bulk of the iron meteorites in that respresentative collection was 13·7 times as great as that of the stony meteorites. Dr. Prior's British Museum Catalogue of Meteorites (1923) includes all those known up to 1922, and has rendered practicable an estimate on a more complete basis. According to the weights and facts recorded in that catalogue, the quantities are:—

	Numbers known.	Approximate gross weight. Tons.
Stony meteorites	125,181	12¼
Iron meteorites	401	263
Stony-iron meteorites	70	15

According to this evidence, nickel iron is twenty-one times more abundant in meteorites than stony material. Hence, if the earth represents a fair average of the material of the universe as revealed by the known meteorites, its metallic barysphere would have twenty-one times the bulk of the stony crust. The barysphere would be a central mass of iron alloyed with nickel, and surrounded by a relatively thin stony crust, about 140 miles thick.

It has been suggested, as by Dr. Prior, from the similarities in composition of the meteorites that they are all derived from a single body, which was a member of the solar system that has been shattered by explosion. If so, the meteorites would give no evidence of the composition of bodies outside the solar system; but the great excess of iron in that body would render probable a similar excess in the earth.

The Evidence of Radioactivity.—The relative thinness of the stony crust is confirmed by the phenomena of radioactivity. The earth is radioactive; but its radioactive power, when measured, was found to be surprisingly weak. As determined by the present Lord Raleigh, the earth's radioactivity can be accounted for if all the radioactive constituents are confined to a depth of about 45 miles. The material below that outer shell is practically non-radioactive. The iron meteorites are one of the relatively few materials that are similarly non-radioactive. This evidence indicates that the earth's outer shell is a layer of rock like the stony meteorites surrounding a core composed mainly of iron and nickel.

The Evidence of Earthquakes.—This conclusion was originally advanced by J. Milne from the study of earthquakes. He found that earthquake waves which, in their course through the earth, go deeper than 30 miles, undergo marked acceleration. Their increase in speed shows that at that depth they enter a denser material, through which the earthquake shock is propagated faster. The material of the highly elastic area where earthquake waves are thus accelerated Milne called "geite," as it is the rock that forms the bulk of the earth, and he concluded that it consists mainly of metals, and chiefly of nickel iron.

Subsequent research has confirmed this conclusion as to the major structure of the earth. It has been shown to consist of an outer stony shell—the earth's crust or lithosphere—which is separated by a fairly sharp surface from the underlying barysphere. This inner mass, being denser, more elastic, and non-radioactive, is probably a mass of nickel iron, like the iron meteorites. That the core of this mass is different in constitution from the rest was shown, also from earthquake evidence, by Dr. R. D. Oldham. He found that certain earthquake waves, namely, the waves of distortion, do not pass through the central region of the earth. Within the elastic barysphere is a centrosphere, which transmits waves of compression but not waves of distortion. It is, therefore, either a liquid or a gas. According to Oldham and Knott, the fluid core was a fifth of the radius, or $^1/_{125}$th of the mass of the earth. But, according to Dr. H. Jeffrey's estimate, half the radius, or an eighth of the mass of the earth, is fluid. The huge centrosphere is regarded as occupied by a liquid mass of nickel iron, which, owing to compression, has a specific gravity of 12.

Such, then, is the general structure of the earth machine. It has a fluid centre, a thick metallic shell, the barysphere, and an outer rocky crust, the lithosphere.

As the earth is approximately spherical, we may regard it as a huge projectile, travelling at an enormous velocity through space. It consists mainly of an iron shell, which, like some of those of modern artillery, is hardened with an alloy of nickel. It might, therefore, be suggested that the earth as a colossal cannon-ball, is not a machine. It has not the guiding or self-propelling power of a torpedo. But the earth is able to perform its main function of satisfying the varying needs of man, owing to such remarkable powers of self-adjustment that it falls within the definition of a machine.

The Evidence of Early Climates.—That the earth had a moderate temperature in the earliest period of which the geologist has reliable evidence, is proved by the delicate test afforded by former climates, as they show that the surface temperature of the earth as a whole was then no higher than at the present day.

The earth in its pre-geological development clearly passed through a stage in which it was so hot that it was plastic and behaved as a fluid body. One relic of this early stage is the high temperature of the earth's interior. That the temperature rises below the surface is well known from the uncomfortable heat of deep mines and from the fact that all deep-seated springs discharge hot water. It issues at the boiling point from some springs and from some flowing wells in Queensland. The rise of temperature underground, *i.e.*, the geothermic gradient, varies according to the thermal conductivity of the rocks and with the geological history of the area. It, therefore, differs in different countries, and even at different depths at one locality. In Europe, the standard rate was long regarded as 1 deg. Fah. for every 53ft. of descent. It has now been reduced by some estimates to 1 deg. Fah. for 58ft.

If the rate continued at 1 deg. Fah. for 53ft., or 100 deg. Fah. per mile, the temperature at 5 miles deep would be over 500 deg. Fah., and at the earth's centre, 3950 miles deep, would be nearly 400,000 deg. Fah. Even that condition would be chilly compared with the temperature, 100 times higher of 40,000,000 deg. Cent., which Sir Arthur Eddington invoked last year, or of the 2,200,000,000,000 deg. Cent. of Sir James Jeans. There is no geological evidence for celestial temperatures within the earth. If the material of most of the interior be metallic, its thermal conductivity should give it a relatively uniform temperature. No known minerals in the earth imply temperatures higher than the 2500 deg. Fah. of sillimanite, or the 3100 deg. Fah. of cristobalite, or the 3450 deg. Fah. of some species of olivine. There is no geological evidence that the central hot mass or thermosphere has a temperature higher than a few thousand degrees.

Hence, though the internal heat is sufficient to drive water and molten rocks to the surface, it was not too high to prevent the early formation of a solid non-conducting crust, which soon became so thick as to prevent the thermosphere having any material influence on climate. The oldest interpretable fossils indicate that at the beginning of geological time the climate of earth was about as warm as in modern times. Evidence of this surprising fact is given by the existence at about the time of the oldest fossiliferous rocks of glaciers in the Yangtze-Kiang Valley, west of Hankow, a place that now has one of the most disagreeable of tropical summer climates. About the same time glaciers nearly reached the tropics in South Australia. Glaciers existed then in parts of the world too warm for them at present. Those glaciers do not imply that all the earth had then a colder climate; but they certainly do prove that the conditions were not tropical over the whole of the earth. Judging from the nature and distribution of the marine organisms nearest in date to these early glacial deposits the mean climate of the earth was similar to that of to-day.

This conclusion is consistent with the general evidence of physical geology that from the beginning of the Cambrian Period, the first of which we have definite evidence, the elements of the weather have always been of about their present strength. Climate has undergone marked local variations. Sometimes it was more uniform than now over the earth. At other times the extremes were greater, for great mountain uplifts render the climate more violent, and increase the local differences; and as the mountains are worn down and the valleys filled with their *débris*, so that the surface of the land is more even, the climate becomes more uniform.

Even allowing for such changes and for those due to different distributions of land and sea, it remains true that the meteorological agents have been remarkably uniform in strength. In rocks of all ages the imprints of the raindrops are of about the same size. The sand grains that were spread over the deserts or heaped in sand dunes, and the ripples on "the sands of time" have been always of about the same size, so the winds must have been of similar force. The size of the particles of volcanic dust and tuff also shows that the ejecta of ancient and modern volcanoes have been scattered by volcanic explosions and winds of similar power.

The Earth in Motion.

The earth is not only a complex structure built up of several distinct parts, but it is in motion at a terrific speed. It is charging through space, with the rest of the solar system, at the rate of 750 miles a minute; it is also travelling along its orbit around the sun more than 1000 miles a minute; and its rotation around its axis gives any place on the equator an additional movement of more than 1000 miles an hour. The fact that the earth holds together in spite of such movements shows that it is strongly constructed; but it is sufficiently plastic, owing to its hot interior, to be automatically moulded into a spheroidal form. It is not now a true spheriod, and has no precise geometrical figure, owing to the deformations due to its irregular contraction. It is therefore more correctly described as a geoid, or earth-shaped, than as a spheroid. It is, however, approximately an oblate spheriod owing to the moulding force of its rotation. The equatorial belt has been thrown outward by the centrifugal force so that the polar diameter is about 27 miles shorter than the equatorial. Moreover, owing presumably to the irregular structure of the crust, the equatorial diameter, from a point south of Sierra Leone to the Central Pacific south of the Marshall Isles, is nearly half a mile longer than the diameter from south of Ceylon to the Galapagos Islands.

The rotation of the earth has not been uniform and it does not run true either in time or movement. Owing to tidal friction it is slowly losing speed and the day lengthening. According to Sir George Darwin and Dr. H. Jeffreys, the earth's day was at one time only five hours long.

Changes in the shape have also affected its rate. For example, the polar regions have been raised and lowered to an extent that would have affected the earth's ellipticity. This fact is shown by the wide-spread occurrence of raised beaches in both the polar regions. These beaches are so regular and horizontal that they have been regarded as due to a rise of the sea, and not a change in the level of the land; they have been attributed to the so-called "eustatic" movements or the world-wide variations of sea level. But these raised beaches are lower and disappear in lower latitudes; thus in the British Isles they are conspicuous in Scotland, but absent from most of England; hence they are clearly not due to a world-wide fall of sea level.

A change in the earth's rate of rotation would produce some circumpolar beaches, for its slackening would lower the sea in the tropics and raise it in the polar regions, for the same reason that a circular elastic hoop becomes elliptical when it is rotated and returns towards its circular form as the speed is reduced. The distribution of the raised beaches is, however, less uniform than it should be if due to the submergence of the polar lowlands owing to the slower

rotation of the earth. Hence it is probably due to the alternate subsidence and upheaval of the polar areas; and if both of them had sagged simultaneously the earth's ellipticity would have been increased and therefore also its rate of rotation. Astronomers were at one time reluctant to admit irregularities in the rate of rotation; but it seems now agreed that some changes have occurred and that they indicate deformations of the earth.

Hence the earth revolves like a badly made and badly mounted fly-wheel, and does not run smoothly as its weight is not evenly distributed, and it is not truly balanced on its axis. A fly-wheel under such conditions is wobbly and its rim vibrates under the unequal stresses. The wobbling of the earth causes some shifting in the position of the poles, as proved by the variation of latitude.

The movement of the poles that has been actually observed is comparatively small, and it has been attributed to causes that would affect the earth's balance but slightly, such as heavy falls of rain and snow upon Northern Asia without corresponding falls in North America. But Dr. Jeffreys has shown that these meteorological factors are not sufficiently powerful to have disturbed the axis of rotation to the observed amount. The deformation of the earth by crustal changes is the more probable cause.

The small proved variation of the poles has led to the belief that they have wandered far from their present positions and have at times even reached the tropics, carrying there a frigid climate and giving the polar zones a spell of temperate or tropical conditions.

Any such migration of the poles has been declared impossible, since a body with so heavy a load on its circumference as the earth's equatorial bulge could undergo but minor oscillation of its axis. That the wandering of the poles has been within very narrow limits is fully consistent with the geological evidence; for time after time, in fact at all times for which we have adequate evidence, the distribution of animal life has been along zones that were in general parallel to the present climatic zones.

Deformation of the Earth and its Relation to Habitability.—The changes in shape of the earth have, however, had an important influence in other respects. The earth cannot be deformed beyond a limited amount or it would become unstable and ultimately fly to pieces. But with the wonderful automatic adjustments of the earth, as soon as deformation renders the crust unstable, stability is restored by relatively rapid earth movements, by which the approximately spheroidal form is recovered.

The convulsions during this process lead to changes in the crust that are indispensable for its primary service. Two essential considerations regarding any machine are its function and its efficiency in the discharge of that function.

We may be excused for being so anthropomorphic as to consider that the main function of the earth is to serve as the home of man; and the lot of man is dependent on the earth's movements in space and on its power of self-adjustment to the changing conditions, both internal and external.

The dominant movements of the earth are its rotation on its axis and its revolution along its orbit around the sun. The daily rotation produces night and day, and that alternate heating during the daytime and chilling at night which causes the land and sea breezes that add greatly to the fertility of tropical coastlands, and to the comfort of life in them. The yearly journey around the sun causes the succession of the seasons and the main atmospheric circulation which carries the moisture raised by evaporation from the seas on to the land, where it falls as rain. The combined rotation and revolution determine the weather and weather changes in all parts of the earth, and thus control the earth as the home of man. The movements within the crust, which depend on its adjustment to the shrinking interior, provide for our many and fastidious needs.

The earth's atmosphere is apparently fickle and liable to great changes in composition; but to serve as the breath of life to man the limits of its variation must be narrow; it must have sufficient moisture to provide adequate fresh water and rain; and it must regulate temperature between the intense heat of direct exposure to the sun and the utter cold that would result from unchecked radiation into outer space. We also require for existence a soil of which the fertility must be renewed as its plant foods are exhausted, and we must have dry land on which to live. And civilised existence requires for fuel, building construction, and machinery, supplies of minerals that can only be formed below the surface of the earth.

The atmosphere consists of gases which have been given off from the cooling and contracting earth; but the maintenance of the special composition which animals breathe, and which protects the earth from undue changes of temperature, is one of the beneficent functions of the sea. The efficiency of the atmosphere depends on its content of carbon dioxide, which is usually about 3 parts in 10,000. Many agencies withdraw this gas from the air; for plants fix carbon in their tissues, coal seams and sheets of limestones bury large quantities of the atmospheric carbon permanently underground, and the weathering of rocks, which is, in the main, the conversion of their silicates into carbonates, uses up carbon dioxide. Other agencies such as volcanoes, the respiration of animals, forest fires, and mineral springs pour carbon dioxide into the air and thus disturb the composition of the air. The sea, however, acts as the great regulator of the atmosphere and counteracts all the disturbing agencies, for if too much carbon dioxide is taken from the air the bicarbonates in the water are dissociated and the sea breathes it forth until the standard proportion is restored. If volcanic activity or forest fires add an injurious amount to the air, the sea absorbs the excess and retains it as bicarbonates. The atmosphere is thus maintained at the special composition necessary for human respiration.

Secondly, man requires dry land that has been drained and left available for his occupation. This need was recognised by the waters being gathered together on the third day of Creation. Land would be of no use to man unless most of its surface were sloping. All the land is constantly being lowered by wind and rain, and would in time be planed so level that the rain water would lie upon it, and collect in the hollows, and be removed only by the slow, chilling process of evaporation.

But thanks to the constant interaction of the unequally weighted crust and the shrinking interior, the surface is being lowered in some places and upheaved in others. The instability of the crust, which we deplore when an earthquake devastates a province or slays a hundred thousand people or shatters picturesque Italian towns, renews the slopes on which the habitability of the earth ultimately depends.

The crustal movements by tilting the surface produce slopes which are essential for the flow of water. If the earth's surface were a uniform plain, the rain and snow that fall on it would not be removed by the rivers, and the land would be one vast dismal swamp, prolific in soft water plants and inhabited by abundant aquatic life. But there would be none of the grassy steppes where have evolved many of the animals most helpful to man, including those used for transport, such as the horse, camel, and yak, those that supply wool and hair for clothing, such as sheep and goats, and those that provide food, such as cattle and sheep.

The upraising of parts of the earth's surface produces slopes which discharge the heavy rainfall of the mountains on to the plains, and drains them so that they are fertile granaries instead of useless swamps; and the slopes maintain the rivers which provide water and water channels to human settlements and nourish the vegetation on the riverside belts during periods of drought.

Thirdly, man requires a soil that will produce the foods necessary for his nourishment; and soil, as farmers know too well, is a delicate instrument that is easily exhausted and rendered infertile. The flow of water, though indispensable, charges the soil heavily for its service. Water is the most active of general solvents; and as it soaks through the soil it removes in solution constituents necessary for the food of plants. Every year enormous quantities of the constituents essential to plant growth are washed out of the land and carried by rivers to the sea.

"The sea is great," says a Chinese proverb, "because it does not reject the tiniest rivulet." And the sea is salt and charged with lime because it receives from all the rivers and rivulets stores of materials which have been dissolved from the land. This process would in time leave in the soil only insoluble materials, such as quartz and silicate of alumina, and the soils would be barren and agriculturally useless.

The earth is saved from this fate by the refertilisation of the soils by fresh supplies of plant foods from the primary rocks of the interior, which are rich in lime, alkalies and phosphorus. Movements within the earth force upward huge masses and vast sheets of igneous rocks, which are ultimately laid bare by the removal of the overlying beds by the various agents of denudation. As the exposed igneous rocks form highlands and mountains their constituents are washed down the slopes and renew the fertility of the lowland plains.

The tilting of the rocks on the surface in consequence of the internal shrinkage makes another essential contribution to the economy of Nature. Many of the most useful minerals, such as coal, oil shale, iron ore, and slate lie in the old rocks, and if they were still horizontal the minerals might be so deeply buried that their discovery would be impossible and their economic working impracticable. But as the rocks have been tilted and folded, the mineral seams in them are exposed on the surface, where they are easily found and can be profitably mined.

Hence the interaction of the different parts of the earth machine has rendered possible the evolution of man and still controls his destiny; for it keeps the earth's surface drained and habitable; it distributes the seas so that the land is supplied with rain and fresh water; it maintains the constituents of the air at the balance required in the breath of life, and it raises from the interior the minerals that renew the fertility of the soil and provide the mechanical engineer with the materials that have rendered possible the development of modern civilisation.

During a storm last week the sea broke through and destroyed a dyke which was being completed along the coast of the Vendée for the reclamation of about 50,000 acres of marsh land. The work had occupied several years.

American Engineering News.

Use of Treated Timber.

The varied uses of wood treated by preservatives—usually creosote—continues to increase year by year in the United States. Statistical records divide this material into eight classes, and in all but two of them the quantities treated in 1929 were substantially greater than in 1928. Wood block flooring for buildings, 22,700,000 square feet, an increase of 104 per cent.; cross arms for poles, 3,158,165 in number, increase 62 per cent.; piles, 25,324,250 lineal feet, increase 25 per cent.; poles, 4,383,768 in number, increase 20 per cent.; bridge and structural timbers, 377,100,000 board feet, an increase of 12 per cent.; railway sleepers or ties, 71,000,000, an increase of 1¼ per cent. On the other hand, wood block paving for streets was only 88,137 square feet, or a decrease of 47 per cent. below 1928, while the long timbers to carry railway points and crossings decreased nearly 1 per cent. or to 173,000,000 board feet. Of the creosote used, 60 per cent. was of American production and 40 per cent. was imported, the grand total being nearly 227 million gallons. In addition, there were 30,000,000 gallons of petroleum, 20,000,000 lb. of zinc chloride, 1,200,000 lb. of preservative salts, and 40,000 gallons of miscellaneous preservative liquids. The use of zinc chloride has been declining steadily for some years. There were 213 treating plants in operation, or ten more than in 1928, including seven new plants and three reopened. Of these, 150 were commercial plants, 33 belonged to railway companies, and 30 were operated by private companies for their own service. Of the railway ties or sleepers, the greater number were oak—of various kinds—with southern pine next and Pacific fir third, these three species representing about 70 per cent. of the entire number of sleepers treated. As the total number of treated sleepers in track increases there is a reduction in the rate of annual increase, owing to their longer life. But the number bored and adzed for spikes and tie plates before treatment is steadily increasing.

Engineering in the Theatre.

While the design of the large and many-storied office building which houses the Chicago opera house and a separate theatre presents many special engineering features, there are numerous engineering problems of a different kind involved in the theatrical construction and equipment of the opera house. The stage is the largest in the country, 120ft. by 75ft., with a height of 146ft. to the gridiron or skeleton floor from which the scenery is handled. A space 50ft. by 40ft. is divided into traps or sections 25ft. by 4ft., each mounted on two hydraulic cylinders 12½in. diameter and 30ft. long, by which each section can be raised 12ft., lowered 12ft., or tilted to an angle of 30 deg. in either direction. All the cylinders are controlled from a valve board. The traps can be covered with rolling floors when the floor sections are lowered. At the back of the stage is a trap 75ft. long and 5ft. wide, which can be raised 5ft. above the stage level or lowered 35ft. to a vault in which the numerous drop curtains are stored. It has a capacity of 7 tons. A steam curtain is provided for scenic effects. Three hydraulic engines with 8 to 1 gearing operate the act curtain, the drape curtain, and the fireproof curtain of steel faced with asbestos and a decorative facing on the outer side. To reduce the size of machinery in the cramped space this steel curtain is operated by steel bands or ribbons, which take much less space than cables on the winding drums. Steel towers carry the bank-light frames, which can be set at any desired height. Three bridges, which also can be raised and lowered to any position, carry the flood lights, arcs and spot lights. About 100 hoisting machines are installed, and sixty of them can be controlled, not only from the fixed control board, but also from a portable board which is hung from the chief electrician's neck. Remote control is used for operating the lights and the scenery hoists. There are no less than 282 lighting controls, for white, yellow, blue, and red lights. Besides elaborate dressing room provisions there is a hospital fitted to take care of emergency cases, slight or serious.

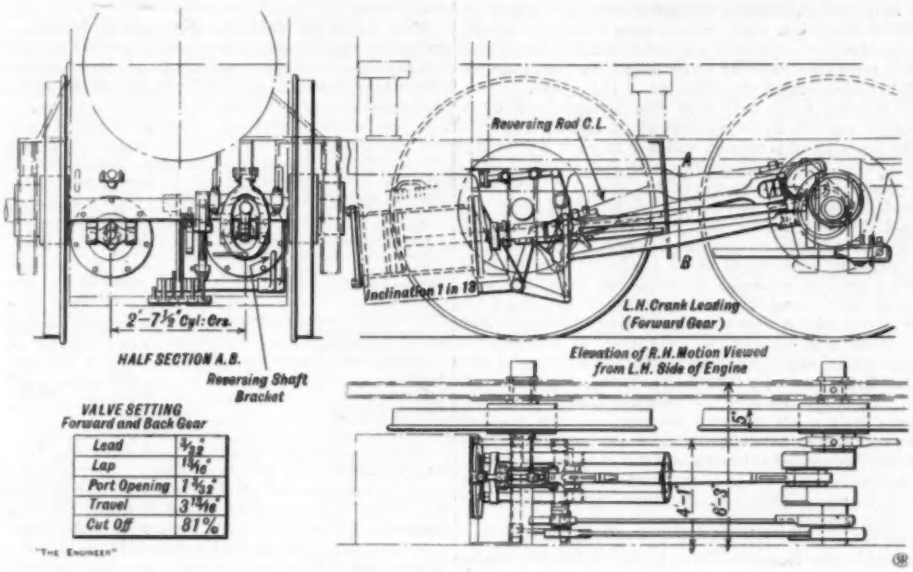
Hopper Dredger with Screening Plant.

While a number of hopper dredgers operate on the Great Lakes to obtain sand and gravel from the lake beds for various commercial purposes, an unusual feature of the dredger "Brazil," operating from Chicago, is that it is equipped with a complete washing and screening plant, so as to deliver a product which is suitable for immediate use as aggregate in concrete. The steamer is 300ft. long, 41ft. beam, and has a loaded draught of 20ft. The dredging pumps are of the centrifugal type, with 18in. suction and discharge, and each is driven by a triple-expansion engine of 450 H.P. As the pumps are below the water line, the suction or inlet pipes are fitted with sea valves, operated by hydraulic cylinders. The 18in. outboard suction pipes, handled by cranes, are 40ft. long, with an elbow at the outer end and a flexible ball joint at the connection with the inlet pipe in the hull. These suction pipes are stowed on deck when the ship is not dredging. The sand and gravel are delivered by the 18in. discharge pipes to a classifying tank with baffles and settling chamber, so that about 60 per cent. of the volume discharged is overflowed, thus eliminating the undesirable fine sand, while the remainder passes to the revolving screens and then to the surface-type classifiers. The screens have holes ¾in. and ⅝in. diameter, as they are found more effective than slotted holes. In the screen jacket the holes are ⅝in. diameter. Continual samples are taken as a check, but the men in charge can regulate the product very closely by judging from the operation of the pumps. In dredging, the ship has bow and stern anchors down and moves over the selected site by hauling in and paying out the cables. In fine weather a full cargo of 1500 cubic yards of screened sand and gravel can be loaded in about ten hours' pumping. In rough weather, with the suction pipes continually lifting off the bottom, a much longer time is required. Gravel and sand are pumped ashore through pipes, being washed down to the suction chambers by streams of water.

The "Lion" Locomotive.

LIVERPOOL AND MANCHESTER RAILWAY, 1838.

PERHAPS the most interesting feature of the Liverpool and Manchester Railway Centenary Celebrations, held at Liverpool from September 13th to 20th last, was the "Train of 1830" drawn by the reconstructed locomotive "Lion," which carried passengers round a circular railway specially laid down on the Wavertree ground.



VALVE MOTION OF THE "LION"

According to Whishaw, this locomotive was built for the Liverpool and Manchester Railway in 1838 by Messrs. Todd and Co. It now appears that the company consisted of Charles Todd, James Kitson and a Mr. Laird, and that they began manufacturing early in 1838. In 1839 Kitson and Laird withdrew and started a new firm, which has developed into the present Kitson and Co., while Todd continued the original business with a new partner under the title of Shepherd and Todd of the Railway Foundry. After 1846 the foundry was carried on by E. B. Wilson and was eventually acquired by Messrs. Manning, Wardle and Co.

Two engines, the "Lion" and the "Tiger," were built at about the same time; the "Lion" is believed to have been delivered in July, 1838, and both were at work before October of that year. Edward Woods, the company's engineer at that time, when sending out a specification for new boilers, quoted these engines as examples to be followed as regards materials and workmanship. The "Lion" was No. 57 on the company's list and was taken over, with other stock, by the Grand Junction Railway in August, 1845. In 1846, when the London and North-Western Railway was formed by further amalgamation, it became No. 116 of that line.

The "Lion" was sold for the sum of £400 to the Mersey Docks and Harbour Board on May 26th, 1859, and worked as a pumping engine at Princes Graving Dock from that date until August, 1928, when it was presented by the Board to the Liverpool Engineering Society, whose property it remains, in order that it might be preserved for the City of Liverpool. It has been restored during the present year in the Crewe shops of the London, Midland and Scottish Railway, with the assistance of Mr. J. G. H. Warren.

The engine is of the inside cylinder, 0–4–2 type, which was one of the forms of six-wheeled engine introduced by Robert Stephenson in 1833, and extensively copied by other engine builders. The cylinders are now 14in. diameter by 18in. stroke, but the figures given by Whishaw in 1840 were 11in. diameter and 20in. stroke. In a list of about 1846, by John Dewrance, who succeeded Edward Woods, the cylinder diameter is given as 12in. and the stroke as 18in., so that it would appear that the cylinders were changed for larger sizes at least twice, but the changes were no doubt made before the engine ceased work as a locomotive.

The driving wheels are 5ft. diameter and the trailing pair 42in. diameter. The wheel base is 12ft., equally divided. The cylinders are placed low down so that the piston-rods pass below the leading axle with an upward inclination of 1 in 13. The valve chests are placed on the tops of the cylinders, as was then usual, and the valves are driven through rocking levers, the upper ends of which are connected with the valve spindles, while their lower ends carry pins with which the excentric rods engage.

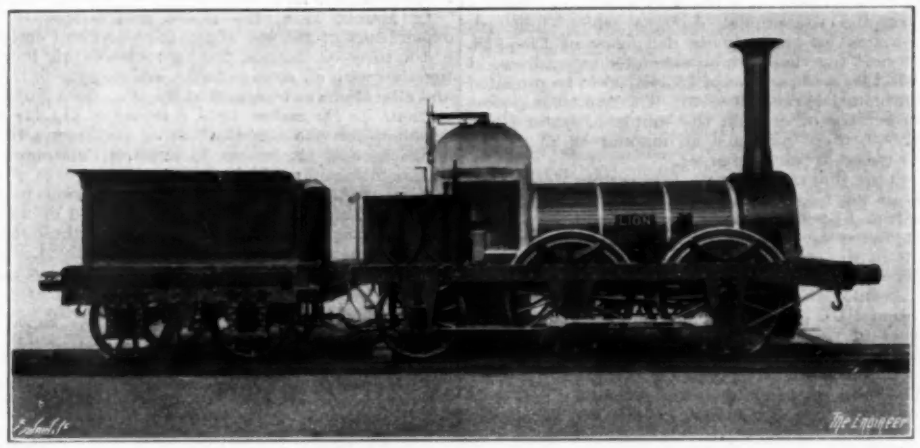
The valve gear is of the four-excentric type, introduced in 1835, in which, for each cylinder, there is a fixed excentric for each direction of motion, and the excentric rod ends are provided with notches or gabs that engage with the pins on the valve levers. The gabs are furnished with spreading jaws or forks, which enable them to engage with the pins without the aid of hand levers on the footplate.

The reversing gear is that variety of the forked gab type introduced about 1840 and usually associated with the name of William Buddicom, who was Edward Wood's assistant at the Liverpool end of the line. In this form the forks of the excentric rods face one another and the rod ends are linked to levers on a reversing shaft placed below them, so that both are lowered or raised together, and either the upper or lower gab is engaged with the pin of the valve lever.

The valves now on the engine have an outside lap of 11/16in. and a travel of 3 11/16in., the cut-off being 81 per cent. When the engine was built the valves had little or no lap, but Woods records that all the Liverpool and Manchester engines were altered or provided with new cylinders and valves, with lap and longer travel, between 1840 and 1842. It was probably at that time that the 12in. by 18in. cylinders were fitted, and very likely the present valve gear as well.

The engine has outside sandwich frames of wood between iron plates, the axle-box horns being bolted to them. Inside the wheels there are two wrought iron frames—extending from the smoke-box to the fire-box—which carry extra bearings for the crank axle only. The springs for the coupled axles are mounted above the frames, and those for the trailing axle below them. The boiler and cylinders are supported by brackets from the outside frames. The guide bars are carried at the front end by the cylinder covers and at the rear end by spectacle plates hanging from the middle boiler support.

The present boiler is of comparatively late date, somewhat larger than the original one, and having a very high fire-box crown. It is not certain what kind of outer fire-box the "Lion" originally had. Liverpool and Manchester engines of the period usually had a slightly raised crown, but Kitson and Laird appear to have favoured the haystack form in their early engines, so that, if they had a free hand in the design of the "Lion," its fire-box may have had that form. In the reconstruction the high crown of the existing boiler has been masked by a cover of the haystack form. Whishaw gives the original boiler dimensions as:—Barrel, 39in. by 42in. and 7·4ft. long; 126 tubes, 1·625in. diameter and 8ft. long; inner fire-box, 30in. long, 39in. wide and 36in. from grate to crown. The total heating surface was 460·3 square feet and the grate area 8·12 square feet. The steam pressure was 50 lb. per square inch and the tractive effort at 85 per cent. boiler pressure is 2499 lb., with the present cylinders. The regulator is within the fire-box crown, which is surmounted by two lever safety valves loaded by Salter spring balances; these balances also serve to indicate roughly the steam pressure. Edward Woods' boiler specification of October, 1838, required a dome over the fire-box with one safety valve, as well as a second dome, another safety valve on a pillar, and a manhole on the boiler barrel.



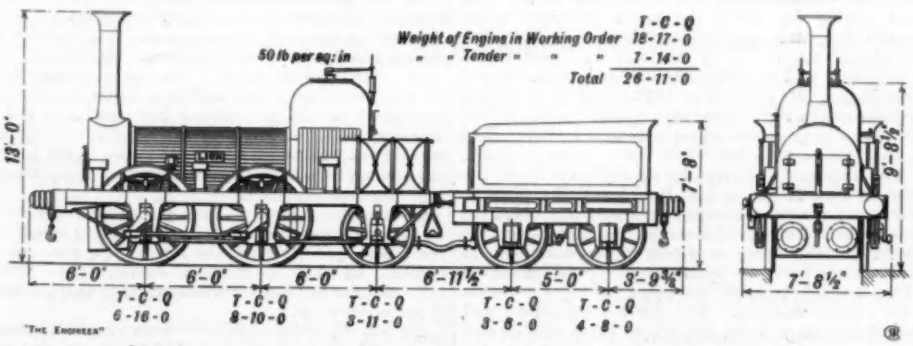
THE RECONSTRUCTED "LION"

The weight of the "Tiger," which was closely like the "Lion," is given by Whishaw as 14·47 tons; in its present state the "Lion" weighs 18·85 tons.

The four-wheeled tender has been adapted from an early tender from the Furness Railway, and is very similar to those in use about 1840. The engine and tender together weigh 26·55 tons, and their overall length is 32·74ft.

The train drawn by the "Lion" consisted of replicas of the first and second-class coaches of 1830, evidently based on the well-known Ackermann prints. The first-class coaches were excellent copies of the reconstructed model of the coach "Experiment," dating from 1834, now belonging to the L.M.S. Railway; but the second-class vehicles, while being apparently copied from the Ackermann prints, were incorrect in that they were seatless. The tickets issued for these were described at the booking office as "third class" instead of second; third class did not, of course, exist in 1830.

The "Lion" is to be given a place of honour at Lime-street Station, Liverpool, over the buffer stops between platforms Nos. 3 and 4.



L. AND M. RAILWAY LOCOMOTIVE "LION" (RECONSTRUCTED)

THE Great Western Railway informs us that among other affairs that will be affected by its new policy in connection with goods services, there will be a reduction in the number of horses used to the extent of 115 animals, which are described as being "released."

Metropolitan Water Board: Annual Report.

From the Twenty-seventh Annual Report of the Metropolitan Water Board, which deals with the year ended March 31st, 1930, and which has recently been published, it appears that the net water rental of the Board during the year was, approximately, £4,474,000, which showed a decrease of £239,630 as compared with the year 1928–29.

Of a total approximate expenditure on revenue account of £5,029,600 for the year 1929–30, no less than £1,803,794 was for interest on debt and £669,000 for local rates. The percentage of collection for the year in respect of domestic supplies and fixed charges was 97·48, the amount collected having been £3,163,976. During the year meter accounts in respect of the four quarters to December, 1929, amounting to £1,246,753, were collectible. The cash actually collected was £1,243,769 and represented 99·76 per cent. of the full amount.

The Metropolitan Water Board (Charges) Act, 1921, provides that the domestic charge shall be at such rate per cent. as the Board shall from time to time fix, not exceeding 10 per cent. per annum of the rateable—now net annual—value of the premises supplied, but that it is not to exceed 8½ per cent. unless and until the Ministry of Health otherwise direct. The Board is bound to fix the domestic rate for each financial year upon the estimates for that year, so that the aggregate proceeds of that rate, together with income from all other sources, shall be as nearly as may be equal to the anticipated expenditure on revenue account in respect of that financial year; but the Board is not required to make any alteration in the percentage rate when the estimated surplus or deficiency does not exceed £250,000.

The Board had reduced the domestic rate from 6½ per cent. to 5¾ per cent. on rateable—now net annual—value for the year 1929–30 and the charges in respect of metered supplies by ¾d. per 1000 gallons in each gradation of the scale. The charges for garden watering, which are assessed on a sliding scale according to the net annual value of the premises supplied, were also revised. From the figures then available it appeared that the year 1929–30 would close with a small deficiency of approximately £23,000, but the heavy additional expenditure incurred by the Board in maintaining the supply during the severe frost in the early months of 1929 and during the exceptional drought which followed, resulted in an approximate deficiency of £288,226. That sum, together with an estimated expenditure of £5,053,140, made a total of £5,341,366 to be provided in the financial year 1930–1931. The estimated income from sources other than the supply of water being £261,000, there remained an amount of £5,080,366 to be raised by water charges.

To raise that income in the year ending March 31st, 1931, it was necessary to increase the domestic water rate from 5¾ per cent. to 6½ per cent. and the charges for metered supplies by ¾d. per 1000 gallons at each point in the scale. Section 18 of the Charges Act, 1921, entitles the Board to charge an additional ½ per cent. per annum on the domestic rate and an additional 1d. per 1000 gallons for meter services in respect of premises in the non-contributory areas, and the Board authorised such additions as from the date of the operation of that Act.

The total quantity of water—in million gallons—supplied during the year under review was as follows:

	Direct area.	In bulk.	Total.
Total volume	99,629·2	816·2	100,445·4
Daily average	272·96	2·23	275·19

The total daily average supply was 0·76 million gallons less than in the preceding year. During the month of maximum supply—June, 1929—the daily average supplied was as high as 300·65 million gallons. The daily average supply per head taken over the whole year was 36·41 gallons, or 0·73 gallon less per head per day than in 1928–29.

The total estimated population supplied by the Board at March 31st, 1930, exclusive of bulk supplies, was 7,548,979, which represented an increase of 120,801 during the year. Of the increase, 63,048 occurred in the area north of the Thames and 57,753 south of the Thames. Of the total, 4,765,181, or 63 per cent., reside in the area north of the Thames and 2,783,798, or 37 per cent., south of the Thames. The number of services was 1,262,928 at March 31st, 1930, an increase of 22,418 during the year. The addition during the year to the number of inhabited buildings supplied was 21,170.

The amount of storage and subsidence reservoir capacity for unfiltered water possessed by the Board at the end of the year was as follows:—

	No.	Area in acres.	Capacity in million gallons.
Thames Valley	32	1,749·5	14,017·5
Lea Valley	17	955·0	5,639·5
	49	2,704·5	19,657·0

On the basis of the demand for water during 1929–30 that volume would be sufficient to provide a full supply—including bulk supplies—for a period of 71·4 days, without drawing upon the various sources of supply.

The coal, coke, oil and electricity consumed during the year was the equivalent of some 202,000 tons of coal, which was nearly 11,000 tons more than in the preceding year.

The Report then proceeds to discuss the various new works which were completed or under construction during the year. Reference is first of all made to the additional filtration arrangements and pumping plant at Kempton Park, which were formally opened by the Minister of Health on October 24th, 1929, and which were described at some length in our issues of October 25th and November 1st of that year.

It is then explained that the construction of a covered concrete service reservoir at Bishop's Wood, in the borough of Hornsey, which is to have a capacity of just over 20,000,000 gallons, was rapidly approaching completion at the end of the year. Then, with regard to Surbiton and Ditton, it is stated that the Board decided during the year that the time had arrived when the reconstruction and remodelling of the pumping stations at those places, which stations were, formerly, separate riverside works of the late Chelsea and Lambeth Water Companies, should be carried out with a view to safeguarding the supply and improving the economical operation of the works, which, owing to the age and scattered positions of the units, had been very expensive both in labour and fuel. Instead, however, of building a new pumping station upon a site midway between the two existing stations, it was found that it would be practicable and more economical to remodel the existing Lambeth engine-houses and coal-house in order to accommodate the machinery and coal-handling plant for both pumping stations.

The total estimated cost of the scheme, which was adopted by the Board in July, 1929, is £220,000, made up as follows:—

	£
Buildings, including alterations and foundations for machinery	72,000
Machinery, including boilers, engines and coal-handling plant	118,000
Mains, culverts, &c.	30,000

In March of this year the Board accepted a tender of £48,980 for the manufacture, delivery, and erection of four steam turbines with centrifugal pumps and two electrical generators at this station. Four of the obsolete engines and twelve boilers have been removed.

In March, 1928, the Board had authorised an expenditure of £35,000 in the provision and erection of the three oil engines, driving reciprocating pumps, together with oil storage tanks, connections to mains and alterations to buildings at the Woodford pumping station. In December, 1929, a tender of £14,229 was accepted for the construction of an engine-house, additions and alterations to existing buildings and other contingent works.

Particulars are then given regarding various mains, the laying of which was either completed or undertaken during the year. The names of these mains and the amounts of the expenditures involved, which include contingent works, &c., are set out below:—

	£
Kempton Park to Hampton (intercommunication main)	60,000
Cricklewood to Fortis Green	46,348
Woodford to Buckhurst Hill	15,081
Acton	8,500
Hanworth, Heston and Isleworth	21,002
Hampton, Hampton Wick, Teddington and Hounslow	12,435
Beckenham and Penge	47,500
Bexley Heath	5,800

Then, with regard to the drought of 1929, the Report goes on to state that as the action it took was the subject of considerable criticism in the Press and otherwise, it would appear to be desirable to make some reference to the subject. The following statement is therefore included:—

"At the meeting of the Board on July 5th, 1929, the Vice-Chairman of the Board referred from the chair to the abnormal increase in consumption brought about mainly by the watering of gardens, sports grounds, &c., and urged the consumers in their own interests to exercise every economy and care in the use of water, and to eliminate all forms of waste and excessive use. He stated that the earnest co-operation of consumers in the matter was a factor which would govern to a large extent the question as to when, if at all, absolute restrictions would have to be imposed. He supplemented his remarks at the meeting of the Board of July 19th, the last Board meeting prior to the summer recess, and regretted that the request for co-operation from the consumers was not given the publicity in the Press to which it was entitled. It was apparent from the quantity of water consumed that little or no attention was being paid by the public to the official warning. The matter, therefore, had reached that stage when the Board, being unable any longer to rely on the voluntary assistance of the consumers, was reluctantly compelled to curtail the supply.

"Notice was given that, in consequence of the unusual drought, the Board, in pursuance of their statutory powers, suspended until further notice the authority granted to use water for (*a*) watering gardens and sports grounds by means of hose, outside tap, or sprinkler; (*b*) washing motor vehicles by means of hose. The restriction so far as it applied to the washing of motor vehicles by means of hose was removed on August 2nd, 1929, and the restriction referring to the watering of gardens and sports grounds by means of hose, outside tap or sprinkler on October 7th.

"Careful consideration was given to the remission of a portion of the charges made for these services, and certain allowances were authorised, such allowances being made irrespective of whether application had been made by the consumer or not, and, where practicable, by way of deduction from the following water rate."

The following table is then given to show the increases which have taken place under the Board's management in the equipment of the waterworks since the transfer of the undertakings of the old water companies:—

	Before June, 1904.	At March 31st, 1930.
Storage reservoirs for unfiltered water	44	49
Acreage	843	2,704·5
Capacity in million gallons	4,115·7	19,657·0
Service reservoirs for filtered water	75	93
Capacity in million gallons	244·5	319·3
Filter beds (slow sand)	137	178
Acreage	139	175·7
Primary filters	—	51
Area in square feet	—	20,064
Mechanical filters	—	12
Area in square feet	—	640
Engines	235	275
Horse-power	32,177	48,903
Miles of water pipes	5,759	7,202

In conclusion, it is pointed out that the Board is responsible for the supply of water to a population of over 7½ millions, which in effect is about one-fifth of the piped population of Great Britain, that is, the population that derives its supply of water from the domestic tap. The Board's supply from the Thames alone—166 million gallons daily average, exclusive of bulk supplies—would suffice for the supply to Liverpool, Manchester, Birmingham, Sheffield, Nottingham, Leeds, Brighton, and Southampton taken together, while the Board's supply from wells alone is nearly as much as would satisfy the needs of Manchester and Southampton together.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

MOTOR CYCLE ENGINEERING.

Sir,—As a subscriber to your journal, I do not recollect ever having read any notice of the annual show held at Olympia of motor cycle products.

From time to time you have given accounts of the exhibits of other engineering products given there and very interesting they have been.

I think it will be granted that all branches of engineering have something to learn from each other, and I think the motor cycle engineer has a record of success that merits some attention from the leading engineering journal.

In the first place, almost alone among our engineering industries he has placed himself in a position of world dominance, so much so that the *Motor Cycle* has been able, every year for since about 1924, to publish an issue entitled the "British Supremacy Number." It would be a nice thing if other trades could do the same and point to such an overwhelming record of victories in every field of competition and volume of business done. It is to be furthermore, borne in mind that this achievement has been carried through despite persistent Press antipathy and opposition in Parliament.

The British motor cycle industry has an export credit far above that of the British private and commercial car trade. In 1929 the credit balance to the combined cars, lorries and parts was £2,031,848, while that of the motor cycle trade was £4,001,900. It is noteworthy that in the first case the figures are less than 20 per cent. of the total export figures, while in the latter the amount is just short of 100 per cent. of the exports. The engineer who can head his foreign rivals so deserves a little notice.

The motor cycle engineer obtains a greater power per cubic centimetre than any other engineer in one case, actually 10 B.H.P. per 100 c.c.; but apart from this his ordinary production job gives an output of 5 to 6 B.H.P. per 100 c.c. He is thus enabled to place in the hands of his consumers a power for acceleration unequalled by any other means of transport.

Great stress has of late been placed by the car trade on their recent efforts to make gear-changing easier. For years, since pre-war days, the motor cycle gear box has required no skill to make a change. The modern roller chain owes its strength and efficiency to the demands of the motor cycle.

The feat of providing the public with a means of personal transport for an inclusive cost of $^{3}/_{8}$d. per mile on a basis of 12,000 miles per year, is no mean one. This cost includes full insurance, tax, replacements and depreciation and fuel. It is interesting to note that the initial outlay for such a performance lies between £20 and £25—the cost of a new machine. These machines will take a pillion passenger, and, in several cases, have sufficient power to pull a sidecar.

The motor cycle engineer can claim to have produced the most stable and go-anywhere vehicle available to the

public. On slippery surfaces it can be driven at high speeds with safety, there being no incipient tendency to "crab." It can traverse surfaces and climb hills which no car can attempt and that without drawing upon its reserve of engine power. It is notorious that in rough trials, where there is a combined car and motor cycle entry, the course which usually succeeds in being almost impossible for cars is not a test for motor cycles at all. This simply means that the motor cycle engineer has placed in the hands of the purchaser of his product a greater available amount of power and manœuvrability.

Finally, his contribution to engine layout is, I feel, no small one. Faced with a demand for more cylinders, not that his products were inflexible before, the British motor cycle engineer has, this year, placed on the market two remarkable "4's." The first, the Matchless, is a very narrow V 4, with overhead cam shaft and air cooled, but the more remarkable design is the Ariel square "4." As a design it gets over troubles associated with multi-throw crank shafts and enables its designer to dispense with plain big ends and so get over lubrication difficulties caused by high rubbing velocities. The engine has done over 9000 r.p.m. on the bench. It is really compact and the principle is capable of extension to larger numbers of cylinders.

When the layouts of the two British "4's" are compared with those of the Continent and of the U.S., the greater ability and originality of our designers is very striking.

I am afraid that this letter has reached an undue length, but as one who is in no wise connected with the motor cycle trade, I feel that a little prominence given to its successful efforts to maintain our supremacy, sadly diminished of late, would benefit other trades if they would but copy its methods of meeting the foreigner on his own ground and giving him a sound trouncing wherever he shows his nose.

Mill Hill, November 10th. W. E. Alcock.

"CREEP" DESIGNING.

Sir,—Increasing interest in the investigation of the "creep" of materials, whether at high temperatures or at ordinary temperatures, evidenced by the leading article in your issue of November 7th, will not, it is hoped, obscure certain other facts or probabilities about materials of construction.

A fact established by tests on cast iron is that it is possible in a short-time test to separate the deformation developed in a test piece by an applied load into two parts, one of which is a function of the applied stress and the other of which appears to be a function of time, temperature and loading. The first is called elastic deformation, and the second may be called plastic yield. What is true of cast iron may also probably be true of concrete and other materials.

There is a distinct probability that plastic yield can itself be subdivided into two parts, the one which is separated out when a test piece is subjected to a succession of loadings and unloadings in a brief space of time, and the other which only comes to light in a long-time test.

An essential fact is that elastic deformation, quite apart from plastic yield or creep strain, does not always give a straight-line relation when plotted against stress. This is the fact which condemns Hooke's Law as the true criterion of elasticity, and not that elastic materials do, as a matter of fact, also possess some measure of plasticity, together with elasticity. This observation is not intended as a criticism of the sterling worth of Hooke's Law to the practical engineer, but of its uselessness in encouraging unbiassed research into fundamentals.

An interesting analogy between "creep" stress in materials of construction and creep stress in foundation material may be traced by an examination of Professor W. S. Housel's tests on the bearing values of certain soils, published in "A Practical Method for the Selection of Foundations based on Fundamental Research in Soil Mechanics"—Bulletin No. 13, October, 1929, of the University of Michigan. In this thesis are plotted corresponding values of settlement and stress for certain specified bearing areas and perimeters. Below a certain stress a limited settlement was measured. Above such stress the settlement showed a tendency to become continuous. The actual results obtained were a function of the time during which the test lasted. The real value of the method appears to be to determine what safe load can be applied to any particular soil tested without producing a measureable settlement after the major settlement—or short-time plastic yield—has taken place.

It would appear reasonable to assume that any further settlement—or long-time creep strain—need not be taken into account unless the design of the structure to be superimposed upon such foundation material also takes into account the probable creep strains within itself.

A. C. Vivian.

Middlesex, November 10th.

AIRSHIPS AND TROPICAL CLIMATES.

Sir,—Your editorial referring to the disaster of the "R 101" on page 401 of the October 10th issue of The Engineer makes the following statement:—

". . . . During the war, in 1917, a Zeppelin airship, the 'Z 57,' had flown from Bulgaria to Central Africa with supplies for the German troops operating in that region. The voyage marked the first occasion on which an airship had passed from northern to tropical latitudes, and in this respect it remains to-day the only one of its kind. . . ."

This statement is hardly quite correct. The "Graf Zeppelin," under the command of Dr. Hugo Eckener, made a round trip from Friedrichshafen to South and North America, early this year, during which it encountered tropical rains and otherwise severe weather conditions. Apart from the difficulties presented by the war conditions, the flight of the "Graf Zeppelin" was made under more difficult conditions than the flight of the "Z 57." However, no trouble was experienced on either flight by the conditions pointed out in your editorial. The successful long-distance flights of the "Graf Zeppelin," which, so far, total more than 150,000 miles, do not seem to agree with your opinions regarding airships.

H. N. Boetcher.

Baltimore, Md., U.S.A.,
October 28th.

[The immediate bearing of the passage quoted by our correspondent was the difficulty or danger of using petrol as fuel in an airship designed for voyages to tropical climates. We would like to have his assurance that on the voyage of the "Graf Zeppelin" to which he refers the fuel used throughout the whole trip was petrol and not partly or wholly the "Blau-Gas" fuel which the airship was designed to employ. Our correspondent will no doubt have noticed that Dr. Eckener himself has recently announced his intention in all future airships of eliminating petrol completely and relying on heavy oil fuel.—Ed. The E.]

HIGH-PRESSURE GAS REACTIONS.

On Friday, October 31st, a public lecture on "High-pressure Reactions" was delivered before the Institution of Chemical Engineers by Professor W. A. Bone, F.R.S., in the Lecture Theatre of the Institution of Civil Engineers.

The lecturer dealt briefly with the historical events leading up to an understanding of the *rôle* played by pressure in gas reactions. Within a period of less than fifty years was included the first recorded synthesis of ammonia from its elements by the agency of a catalyst, the statement of the principle of mobile equilibrium, and the classical work of Haber and his collaborators upon equilibrium in an ammonia-nitrogen-hydrogen system. A more recent development had been the synthesis of various organic compounds from water-gas by the employment of suitable catalysts and high pressure, which had opened up a wide field for future exploration. It seemed probable that in the course of the next few years the chemical industry would be profoundly affected by the result of work now in progress.

The variety and complexity of these new processes, however, called for much systematic and fundamental research before a clear understanding of their mechanism could be obtained. A large amount of work had already been carried out, but a glance at the patent literature of the last few years would show that much of it had been of a purely empirical character and that a great deal of unnecessary overlapping had taken place.

Professor Bone devoted a portion of his lecture to a consideration of the logical method of developing a reaction from a laboratory experiment to a works scale process. Anyone engaged on the study of high-pressure gas reactions would be aware of the difficulties encountered through the lack of reliable fundamental data on the physical properties of gases. No more useful link could be undertaken at present than a comprehensive determination or re-determination of such data as the compressibility of gases and of mixtures of gases and the effect of pressure on viscosity, dielectric strength, solubility and thermal conductivity. Although such work fell within the scope of a high-pressure gas research laboratory rather than of a works routine laboratory, the cost of equipping and maintaining such a laboratory had hitherto proved an insuperable barrier.

Some three years ago, however, a complete high-pressure gas research laboratory had, he said, been established in the Department of Chemical Technology at the Imperial College of Science, and work on a number of physical problems directly connected with high-pressure reactions had been begun. The lecturer gave a brief account of the progress made up to the present time, including the results of determinations of equilibria in various gaseous systems, of isotherms, of gases and gas-vapour mixtures and of experiments on the production of oxides of nitrogen in gaseous explosions.

CONGRESS FOR MECHANICAL ENGINEERING.

At the final session of the International Congress for General Mechanics—Congrès International de Mécanique Générale—which was recently held at Liége, the President, Monsieur Hanocq, put before the meeting the following resolutions:—

(1) That there is need for the creation of a permanent organisation empowered to arrange the future sessions of the Congress for Mechanics with special reference to its application to industries, similar to that for General Mechanics which was held at Liége in September, 1930;

(2) That the Congress should be called the "Congress for Mechanical Engineering," in default of a better title, so as to avoid all possible confusion with "Applied Mechanics";

(3) That a Committee, composed of one member from each country represented at the Liége Conference, should be appointed;

(4) That the delegates of three countries—Belgium, Holland, and Switzerland—should be charged with the business of negotiating with the various national organisations so as to arrive at an agreement which would render the work permanent and international;

(5) That these three delegates should report to the General Committee, not later than a year from the date of the closing session of the Congress, and, should there be a check in the negotiations, that they could call a meeting of that Committee to decide what steps should be taken;

(6) That the Committee should only refrain from calling a new session if the negotiations showed that the refusal of certain countries to participate was due entirely to technical considerations.

These resolutions were passed unanimously, one delegate only making an observation regarding the title chosen for the proposed Congress. It was decided to embody his observation in the "Proceedings," so that the delegates might be able to consider it next year when the title of the Congress would be definitely chosen.

The names of the delegates subsequently chosen to form the Committee were:—Abdel Raman el Sawi (Egypt), Adamson (Great Britain), Antonopoulos (Greece), Anzola (Venezuela), Aparicio (Colombia), Bambula (Austria), Canale (Argentina), Caquot (France), Chaban Bey (Turkey), Cizurovics (Latvia), Colombi (Switzerland), Cosulich (Italy), de Krauze (Poland), Germani (Rumania), Hanocq (Belgium), Hanquet (Peru), Jirak (Czechoslovakia), Maugas (Luxembourg), Omoto (Japan), Parkin (Canada), Pirow (Union of South Africa), Ramos (Brazil), Regout (Bolivia), Solorzano (Mexico), Tanto (Hungary), Tegelberg (Holland), Thomsen (Denmark), Vanderwilligen (United States of America), and Wiberg (Sweden).

B.E.S.A. SPECIFICATIONS.

COLOURS FOR READY MIXED PAINTS.

Builders, decorators, painters—and the ordinary householder—will welcome the publication, by the British Engineering Standards Association, of a British Standard Schedule of Colours for Ready Mixed Paints. This schedule was prepared by a Sub-committee of experts of the regular Technical Committee on Paints and Varnishes, which, early in its work, became convinced of the desirability of such a publication. The examination of a very large number of colour cards showed that there were nearly 3000 different colours on the colour cards issued by manufacturers and suppliers of ready mixed paints alone and many hundreds of different shades of some of the colours. In addition, there were many names for the same colours.

The work of the Committee was threefold:—

(*a*) To select a reasonable number of popular colours for standardisation.

(*b*) To find an agreed name for each colour.

(*c*) To include a colorimetric analysis by some agreed method so that the colour standard could be maintained, regardless of any fading of the colour patterns.

The schedule contains fifty-seven colour patterns with agreed colour names and in every case the endeavour has been to make these names self-explanatory to the ordinary user and to avoid technical terms.

Appendices give the colorimetric value of each colour, measured at the National Physical Laboratory on the Guild colorimeter, and a specification of the celluloid used to mount the colours.

The best available knowledge regarding the permanence of the colour samples has been available to the Committee, and experiments are being made in various parts of the world to test, under the most severe climatic conditions, the permanence of the actual colour samples included in the publication. Future editions will have colours which agree with the colour analysis and will therefore be exact reproductions of those now issued, so that even if absolute permanence has not yet been achieved in the production of all the standard samples, that will not interfere with the establishment of the standard of colour. The Standards Association is making arrangements to have colour measurements made periodically and a new edition will be published if and when necessary.

Copies of the schedule, B.S.S. No. 381–1930, may be obtained from the Publications Department, British Engineering Standards Association, 28, Victoria-street, London, S.W. 1, price 7s. 10d. post free.

STEEL GAS CYLINDERS.

The British Engineering Standards Association has just issued a British Standard Specification for High Carbon Steel Cylinders for the Storage and Transport of "Permanent Gases."

This specification, which is based on the recommendations for ordinary commercial cylinders for the transport of the so-called "Permanent Gases" included in the First Report of the Gas Cylinders Research Committee of the Department of Scientific and Industrial Research, provides for high carbon steel gas cylinders for the storage and transport of such gases as atmospheric air, oxygen, nitrogen, hydrogen, &c., which, at the usual working temperature and the maximum working pressure of 120 atmospheres, remain in a gaseous state in the cylinder.

The specification includes particulars of tensile, impact, flattening and hydraulic stretch and pressure tests, together with a formula for the determination of the minimum thickness of cylinder walls.

This specification is the first to be published of three specifications, which are in course of preparation by the Gas Cylinders Committee of the Association, for gas cylinders. It is expected that the two remaining specifications for Low Carbon Steel Cylinders for the Storage and Transport of "Permanent Gases" and for Steel Cylinders for the Storage and Transport of "Liquefiable" Gases, will be available shortly.

Copies of this Specification No. 399–1930 can be obtained from the British Engineering Standards Association, Publications Department, 28, Victoria-street, London, S.W. 1, price 2s. 2d. post free.

In order to facilitate the melting down of scrapped automobiles, the Ford Motor Company, Detroit, has ordered a 400-ton tilting open-hearth furnace from the Pennsylvania Engineering Works, New Castle, Pa. It is said to be the largest open-hearth furnace in operation in the United States and will be specially equipped to be charged with crushed automobiles taken off the dismantling line at Fordson.

Some Considerations Affecting Future Development of the Steam Cycle.*

By K. BAUMANN.*

No. II. (*Conclusion*).†

(e) DESIGN OF PIPE FLANGES.

Tightness of Flanges.—The question arises as to what conditions must be met to prevent leakages in flange joints. Referring to Fig. 8, the bolts must be able to take the thrust due to the steam pressure. It is usual to assume that this will be exerted on the diameter of the pipe and the area of the joint surface. In addition, the bolts must produce a certain pressure over the joint surface "S," which must bear some relation to the steam pressure. On the assumption that the pressure per square inch on the joint surface would be m times the steam pressure, we obtain for the total force to be exerted by the bolts the following value :—

$$S\,b=\frac{\pi}{4}\,D^2\,p\,k,\ \text{where}\ k=1+4\,(m+1)\,\frac{S}{D}\left(1+\frac{S}{D}\right)$$

for D = 10in., S = ½in., *i.e.*, $\frac{S}{D}=0{\cdot}05$

and for $m=0$;	$k=1{\cdot}21$
1	1·42
2	1·63
3	1·84
4	2·05

It is doubtful whether the joint can be maintained with a pressure at the joint less than double the steam pressure, so that the stress in the bolts must be at least 1¾rds times that resulting from the steam thrust caculated on the internal diameter of the steam pipe.

It is customary to tighten the bolts to a higher stress than is suggested by the above formula and also good practice, provided care is taken that the bolts are not stressed above the elastic limit when cold. Bolts so tightened, at least for high pressure or high temperature flanges, should preferably be measured for extension, and the tightening up is facilitated by heating the bolts.

Life of Flanges During Normal Operation.—It is assumed in the first place that the pipe has been put under pressure and that flanges and bolts have been brought up to normal temperature, and that this temperature is uniform throughout the flange joint. The flange itself is assumed to be rigid compared with the flexibility of the bolt. The stress in the bolts may be 10 tons per square inch at a given time. The creep rate of the bolt material at a given temperature is assumed to vary with stress, according to curve A—Fig. 8. This straight line relationship between stress and logarithm of creep rate holds with reasonable accuracy, as may be seen by comparison with the creep rates shown in Figs. 3 and 4. The stress of 10 tons per square inch being within the creep range, the bolt will start to creep, *i.e.*, extend in length quickly at first, more slowly later, thus reducing the stress in the bolt. This decrease in stress is shown in curve B of Fig. 8. It will be seen that after 900 hours the stress is reduced to 6 tons per square inch, and after 9300 hours to 3 tons per square inch, which is the stress corresponding to a creep rate of 10^{-6}. If the steam thrust corresponds to this stress, the pressure between the joint faces will have disappeared completely, and the joint is bound to leak. Most probably, the joint would have started to leak after 4000 hours, when the stress was reduced to 4 tons per square inch, and the pressure between the joint faces was reduced below double the steam pressure. The sharp initial drop in the bolt stresses indicates that the initial tension in the bolt does not affect the life of the joint appreciably. Curve C shows the fall in the stress in the bolt on the assumption that the flexibility of the flange is equal to the flexibility of the bolts, but that the stress in the flange does not cause any creep of the material. In this case the life of the joint is doubled. If the flexibility of the flange is increased still more to four times the flexibility of the bolts, the life of the joint becomes five times that obtained with rigid flanges.

Curve B applies also to the hypothetical condition of rigid bolts and a flexible flange, the flexibility and the creep rate of which are equal to those of the bolts just considered, and, consequently, curve B also applies to the case when equal flexibility and equal creep rate in both bolts and flanges are obtained.

Similarly, it can be shown that for any ratio

$$n=\frac{\text{flexibility of flange}}{\text{flexibility of bolt}}$$

and for any ratio

$$p=\frac{\text{creep rate of flange}}{\text{creep rate of bolt}}$$

and that the time required for the stress to fall from one given value to another is $q=\frac{1+n}{1+p}$ times that given by curve B.

Thus, curve C holds for all values of n and p, which produce $q=2$; for instance—

$n=1$	$p=0$,
$n=2$	$p=\frac{1}{2}$,
$n=3$	$p=1$, &c.

The parameter q is a direct measure of the relative life of a joint.

It should be noted that creep of the flange is a much more complicated process than creep in the bolt, because the stresses in the flange are largely bending stresses and creep produces a redistribution of stress.

The following three deductions from this analysis are worth special mention :—

(1) If the stress in the bolts due to steam thrust alone produces creep of the order of 10^{-6}, it may be possible to keep the joint tight for approximately one year, but not longer, providing the flexibility of the flange is at least equal to that of the bolts and provided the stresses in the flange do not produce creep. With Cr-Mi-Mo alloy steel with creep characteristics shown in Figs. 2 and 4 and a bolt temperature of 800 deg. Fah., the corresponding stress would be approximately 65 tons per square inch—

For 850 deg. Fah.	..	..	..	4 tons per sq. inch
„ 900 „	..	..	..	2·5 „ „
„ 950 „	..	..	..	1·5 „ „
„ 1000 „	..	..	..	1 „ „

(2) Flexibility in the flange is very desirable, provided the stresses in the flange do not cause creep. A flange of which the flexibility equals that of the bolts compensates for a reduction in creep strength of the bolt of, roughly, 25 per cent., or, alternatively, doubles the life of the joint.

(3) With a rigid flange, the life of the joint is independent of the length of the bolt, both creep and flexibility being increased in proportion with the length, and their individual effects are compensated. The use of a longer bolt is beneficial only if the addition of a washer or the like adds to the flexibility of the flange, but does not add proportionately to the creep rate. In general, the life of a joint is only increased by additional flexibility if this additional flexibility does not involve a proportionate increase in the creep rate of the structure.

Some Characteristics of Loose Flanges.—In view of the importance of the relative flexibility of flanges and bolts, the use of a loose flange is of special interest. It is more flexible than the solid flange, and its flexibility and the stresses can be more readily calculated and high-grade material can be chosen from the point of view of creep strength.

The curves A, B, C, D, E and F in Fig. 10 show the stresses and the flexibilities in both bolts and flanges as a function of the thickness of the flange. The joint is suitable for a pipe 8½in. bore and a steam pressure of 1400 lb. per square inch. The stresses in both the flange and the bolts are the same for a flange thickness of 4·66in. The flexibilities in both the flange and the bolt also become equal for about the same thickness of the flange. If the shank of the bolt is machined down to the root diameter of the thread its flexibility is increased and it becomes equal to the flexibility of a flange of 4·2in. thickness.

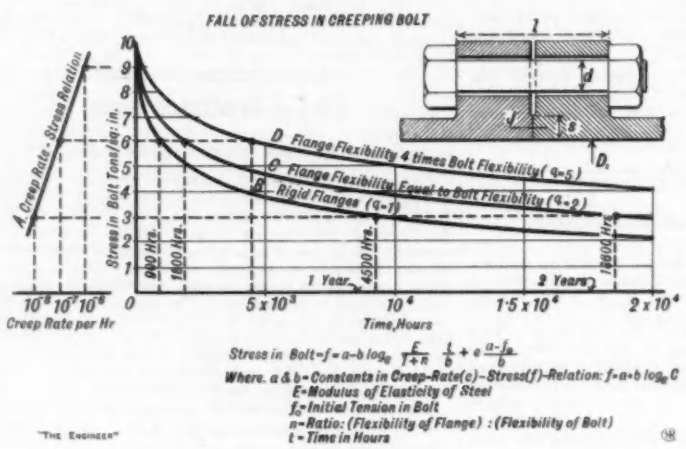

FALL OF STRESS IN CREEPING BOLT
A Creep Rate - Stress Relation
Stress in Bolt Tons/sq: in.
D Flange Flexibility 4 times Bolt Flexibility (q=5)
C Flange Flexibility Equal to Bolt Flexibility (q=2)
B Rigid Flanges (q=1)
900 Hrs.
1800 Hrs.
4500 Hrs.
9300 Hrs.
1 Year.
2 Years.
Creep Rate per Hr
Time, Hours
Stress in Bolt = f = a − b log e F/(1+n) 1/b + e (a−f0)/b
Where, a & b = Constants in Creep-Rate(c)–Stress(f)-Relation: f = a − b log e C
E = Modulus of Elasticity of Steel
f0 = Initial Tension in Bolt
n = Ratio: (Flexibility of Flange) : (Flexibility of Bolt)
t = Time in Hours
"THE ENGINEER"

FIG. 8

Fall of Stresses in Bolt under Creep.

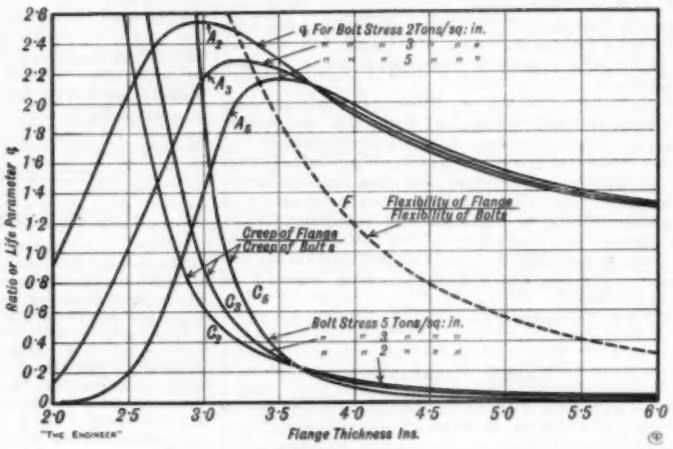
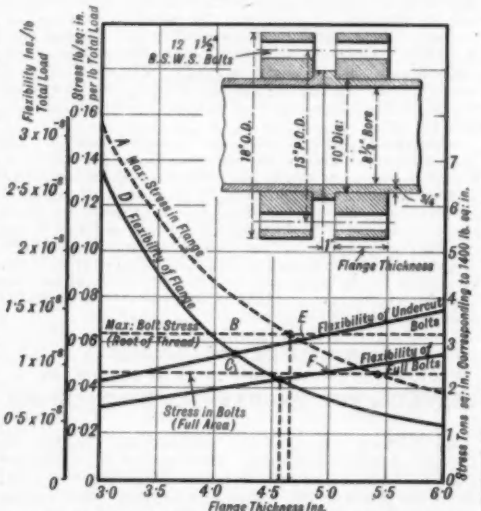


FIG. 9

Relative Life of Loose Flanges with Undercut Bolts.



NOTES. Flange Stress is Calculated by Waters & Taylor's Method (Mech. Engg. May [pt 2] 1927) with Correction for Effect of Bolt Holes. Flange Flexibility at Bolt Pitch Circle is Calculated by Waters & Taylor's Method with Allowance for Deflection by Direct Compression and by Shear.

Stress & Flexibility of Bolts are Calculated for Full Ring of 12 Bolts.

"THE ENGINEER"

FIG. 10

Stresses and Flexibility of Loose Flanges.

The question arises as to how to proportion the flanges and bolts to obtain the longest life for a given material. It has been shown that the parameter $q=\frac{1+n}{1+p}$ is a means for comparing the life of a joint with that obtained with a rigid flange, the bolt stresses being the same in both cases.

The ratio n has been plotted for various thicknesses of the flange in Fig. 11 for both the full bolt and the undercut bolt.

The determination of the value p presents greater difficulties for the following reasons :—

(1) In the absence of test results on creep of flanges, or even bars under bending, the relation between maximum bending stress calculated in the customary manner and creep cannot be predicted with certainty. The redistribution of stress in a bar under bending is not known. An analysis of the probable conditions based on existing knowledge of creep is urgently needed. For the purpose of the calculations given below, it was assumed that creep of the flange in the direction of stress varies with the maximum stress according to a logarithmic law of the same nature as the creep of the bolt.

(2) The relationship between the life and parameter q only holds if, when a flange slackens, the ratio of the creep in a bolt and the creep in a flange remains constant. According to the creep rate stress relation shown in curve A, Fig. 10, this would apply only for the case where the materials for both bolt and flanges, as well as the stresses, are the same. If these conditions do not apply, then the parameter q changes during the life of the joint, and the true life must be obtained by a complicated process of integration of the true fall in stresses which varies with time.

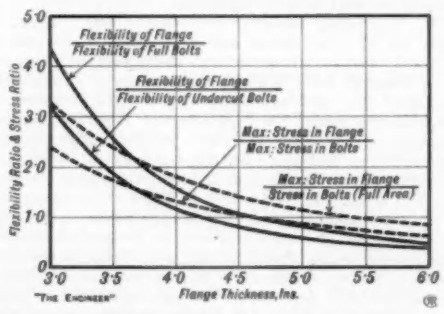

Flexibility Ratio & Stress Ratio
Flexibility of Flange / Flexibility of Full Bolts
Flexibility of Flange / Flexibility of Undercut Bolts
Max: Stress in Flange / Max: Stress in Bolts
Max: Stress in Flange / Stress in Bolts (Full Area)
Flange Thickness, Ins.
"THE ENGINEER"

FIG. 11

Ratio of Stresses and Ratio of Flexibility in Loose Flange Joints.

In view of the limitations stated above, the calculations which are given below are only to be considered as qualitatively correct, but not necessarily quantitatively. They, however, serve to prove a few rules, the accuracy of which will not depend on the uncertainty of the factors stated above.

It can be shown that the creep of the flange measured in the direction of load is approximately inversely proportional to the flange thickness for a given creep in the direction of stress. It follows, therefore, that for given stress conditions, the creep of the flange measured in the direction of load is inversely proportional to the flange thickness, whereas the creep of the bolt is proportional to the flange thickness.

The life parameter is plotted in Fig. 9 for the case that the physical properties of the materials used for the bolts

* Institution of Mechanical Engineers, North-Western Branch, November 6th.—Abridged.

† No. I. appeared November 7th.

and the flanges are identical. For a flange thickness above 3½in. the three curves calculated for bolt stresses of 2, 3, and 5 tons per square inch respectively differ little from one another, whereas for thinner flanges the parameter depends to a large extent on the stress in the bolts. This means that for thin flanges the life parameter varies considerably during the life of the joint, and the actual life would have to be determined by a further process of integration. As the true life lies between the curves given for the various stresses, it follows that for thick flanges the curves shown indicate the true life with considerable accuracy.

The following conclusions can be drawn from Fig. 9 :—

(1) The maximum of life is obtained for a thickness of the flange between 3in. and 3½in.

(2) The maximum life of the joint occurs at a point where the flexibility of the flange is about double that of the bolts—see curve F.

(3) The life decreases slowly with increased thickness of the flange and finally the life parameter reaches the value of 1—*i.e.*, that for a rigid flange.

(4) The life decreases rapidly with decreased thickness of flange on account of the rapid increase of the creep of the flange. The latter is indicated by the curves C_2, C_3, and C_5, showing the ratio of—

$$\frac{\text{creep of flange}}{\text{creep of bolts}}$$

If the creep strength of the material used for the flange is lower than that of the bolts, the position is changed, as shown in Fig. 12, curve A_3, being the same curve as A_3 in Fig. 9. Curve B_3 shows the life parameter for the joints, in which the creep strength of the flange material is only half that of the bolt material. The maximum life is reduced in the ratio of 2·3 : 1·37, and the thickness of the flanges for maximum life is increased from 3·2in. to 4·7in.

It has been suggested that it is beneficial to reduce the diameter of the shank of the bolt to the root diameter of the thread. In Fig. 12, curves A_3' and B_3' show the life of joint with full bolts in relation to the life of the joints using undercut bolts—curves A_3 and B_3—for the same loading of the flange. On account of the decreased rate of creep of the full bolt, resulting from the lower stresses in the shank of the bolt, the life of the joint is roughly

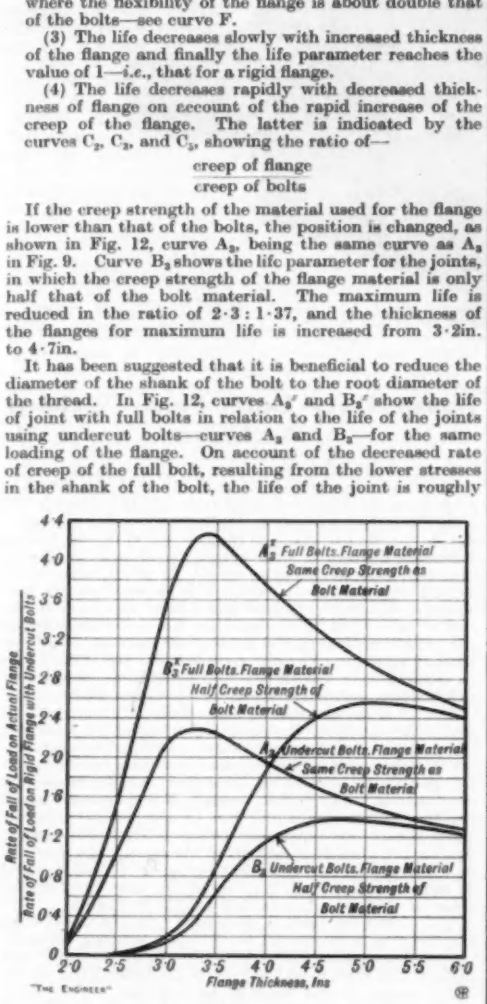

Rate of Fall of Load on Actual Flange with Undercut Bolts
Rate of Fall of Load on Rigid Flange with Undercut Bolts
A'3 Full Bolts. Flange Material Same Creep Strength as Bolt Material
B'3 Full Bolts. Flange Material Half Creep Strength of Bolt Material
A3 Undercut Bolts. Flange Material Same Creep Strength as Bolt Material
B3 Undercut Bolts. Flange Material Half Creep Strength of Bolt Material
Flange Thickness, Ins
"The Engineer"

FIG. 12

Relative Life of Loose Flanges showing Comparison of Full and Undercut Bolts.

doubled, which clearly proves that the practice sometimes suggested is erroneous.

(4) *Behaviour of Flanges during Starting Up.*—If during normal operation the bolt and the flange are at the same temperatures, it follows that when cold the stresses will be the same as when under load, provided the coefficient of expansion of the material in both flange and bolts are the same. During warming up, the temperature in the bolt will not be raised as quickly as the temperature in the flange, with the result that both the bolt and the flange will be subjected to higher stresses. If the elastic limit is exceeded, the bolts and possibly also the flanges may be permanently stretched, and this may cause a leakage of the joint. As these stresses occur at lower temperatures than the normal, and as the starting up periods are of short duration, the question of creep will not usually enter into consideration.

The conditions obtaining during the starting period are shown in Fig. 13 for the flanges, which have been in use for some time at the Mannheim power station for a steam pressure of 1420 lb. per square inch g. (100 atm.) and a steam temperature of 870 deg. Fah. It has been reported —*V.D.I.*, September 5th, 1930, p. 1237—that difficulties have been experienced owing to stretching of the bolts, which occurred during starting up periods. This conclusion was arrived at after examining the stresses which were likely to occur owing to the difference in the temperatures of the bolt and the flange ; the flexibility of the flange being considered negligible. From temperature measurements on other flanges it was assumed that during starting the maximum difference in temperature of the flange and the bolt was about 180 deg. Fah. (100 deg. Cent.). During normal operation this difference was reported to be about 25 deg. Fah., the temperature of the flange itself being about 25 deg. Fah. less than the temperature of the steam.

The diagram in Fig. 13 shows approximately the conditions which obtain under these conditions.

The stress in the bolts based on steam thrust alone is 3·1 tons per square inch. In this case, the stress was calculated in accordance with the practice adopted in Germany on the assumption that the steam thrust acts on the area of a circle whose diameter is equal to the mean diameter of the joint face. The initial tension when cold was reported to be 9·0 tons per square inch. During warming up the stress in the bolt would vary according to curve B, and reach the high value of 25 tons per square inch if the flange was rigid. Actually, the flexibility of the flange is about 1·58 times that of the bolts, and consequently the stress only reaches a value of 15 tons per square inch shown in curve C. Even this stress, however, exceeds the yield point—curve D—of the material used for the bolts by a small amount, with the result that the bolt is stretched and the initial tension is lowered, until, after repeated starting and stopping, the stress in the bolts would vary according to curve C 1, which is, however, still sufficient to maintain the joint. The explanation offered, therefore, cannot be accepted. The obvious explanation lies in the fact that the bolt was subject to creep during the normal operating conditions. Judging from the data given in Figs. 1 and 2, steel is subject to creep at a rate of at least 10^{-6} strain per hour, at a stress of less than one-third of the yield stress—*i.e.*, about 3 tons per square inch.

In the case of the Mannheim joint, the yield point of the bolt material under the normal operating temperature was 9 tons per square inch, while the creep rate with a stress of 3 tons per square inch would be at least 10^{-6} strain per hour.

As this stress is equal to the stress produced by the steam thrust alone, it follows that the failure of the join. was bound to occur within at least a year. To overcome the difficulties experienced, it was decided to use steel —Krupp E.F.D. 70—having a considerably high yield point—curve D^1. As the creep strength of this new material will no doubt also be greater, the life of the joint will be increased, not because stretching of the bolt will not occur during starting periods, but because the rate of creep during normal operation will be reduced. The decision, however, to reduce the diameter of the bolt to the root diameter of the thread, shown on the right in the section of the flange, Fig. 13, would appear, however, to

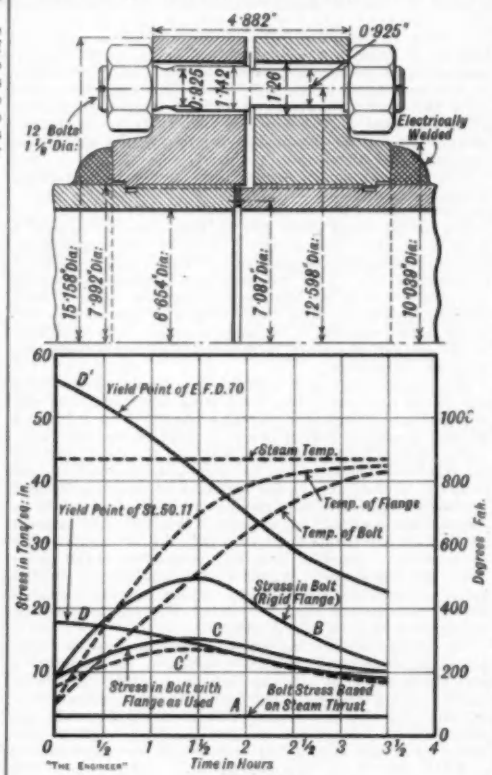


FIG. 13

Stresses in Joint during Starting Up.

be of doubtful benefit judging from the conclusions arrived at in Section (c) (3).

The difference in the temperatures of the bolts and the flange which are reported to be obtained during starting periods appear large, but even with this large difference in the temperatures, the analysis of the conditions obtained shows that the life of the joint depends on the creep characteristics of the material under normal operating conditions. Nevertheless, it is obvious that frequent heating and cooling may cause extension of the bolts if the heating takes place rapidly.

It is of interest to note the effect of the difference between the steam temperature, the temperature of the flange, and the temperature of the bolt, obtained during normal operation.

It would obviously be beneficial if the temperature throughout the joint could be kept below the temperature of the steam. According to Fig. 2 the creep strength for a creep rate of 10^{-6} is increased roughly 25 per cent. for every 25 deg. Fah. lower temperature, and this is roughly equivalent to doubling the life of the joint. With the customary constructions of steam pipe joints a lower temperature is only obtained as a result of heat loss by convection, the lagging not being a perfect insulator. As the bolts are further removed from the steam, their temperature would normally be lower than the mean temperature of the flange. Consequently, the stresses in the bolts and the flanges will be greater during normal operation than when cold, and the pressure between the joint faces will be increased. The period during which this pressure can be maintained during normal operation, however, depends on the creep strength of the material, and if the difference in the temperatures of the bolt and the flange exceeds a certain limit, it follows that when cold, the pressure between the faces will disappear and the joint will leak when put under pressure. As the joint heats up, however, the bolt will heat less quickly than the flange and the joint will become tight.

The decreased stresses in the joint when cold may be the source of difficulties, as additional bending stresses may occur, unless the joints are located in those parts of the pipe line where bending stresses are small. These difficulties could be minimised if the coefficient of expansion of the bolt material were slightly higher than that of the material used for the flanges.

It is apparent, therefore, that there is a definite limit to the difference in the temperature of the bolt, and that of the flange from this point of view.

In addition, a relatively large difference in these temperatures will also involve a correspondingly increased difference in temperatures during starting up, as an unsatisfactory lagging of the joint would undoubtedly introduce greater temperature stresses than a perfect lagging during starting up, which would produce stretching not only of the bolts, but also of the flange.

The flanges are subject to a higher temperature than the bolts, and for this reason they are liable to creep to an extent which has probably not been appreciated sufficiently. Measurement of flange distortions is not easily carried out, and it is possible that they have escaped notice. In view of the high stresses existing in the Mannheim flanges, it will be of interest to watch further developments.

It is evident that flange joints for high pressures and temperatures have a limited life, but that a new lease of life can be obtained by the simple process of tightening the bolts. If the bolt material is satisfactory, and is not liable to become brittle, it is not advisable to replace them unless a better material can be obtained. New bolts of the same material are liable to creep during the first stage which is of relatively short duration at a considerably greater rate than that which occurs during the second stage and which has been the subject of our considerations.

It has been determined by test that Cr-Ni-Mo steel, which creeps at the rate of 2×10^{-6} during the second stage, has an initial creep totalling 10^{-4} in 200 hours, or roughly one-fourth of the elastic extension. This corresponds to a creep which will occur during 5000 hours in the second stage.

The effect of this initial creep can probably be compensated by applying additional initial tension. It would not seem desirable, however, to apply this method on flanges which have already been "seasoned," as this would cause an additional distortion of the flanges.

It is a matter for further investigation whether or not it would be better to submit new bolts, prior to their use in flanges, to stresses at the appropriate temperature in order to pass them through the first stage of creep.

The conclusions which have been arrived at in these notes emphasise the urgent necessity for systematic investigations on the behaviour of flange joints at high temperatures and pressures on a greater scale than has been contemplated hitherto.

The Multiple Superheater Boiler.

The investigations indicate that the steam temperature for power stations is limited by the creep properties of existing materials, and that steam plants for temperatures above 800 deg. Fah. require very careful examination

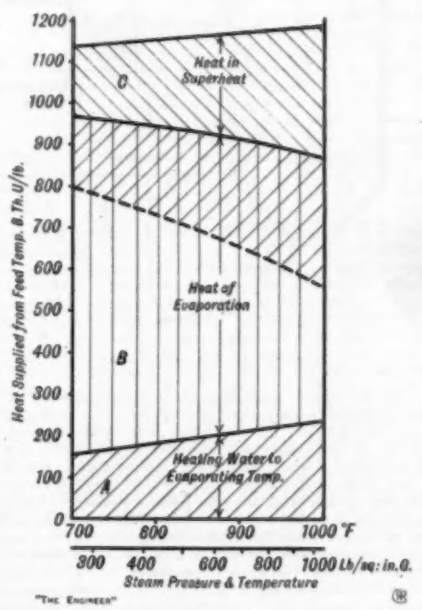


FIG. 14

Heat Transmitted in a Boiler.

from this point of view. Creep characteristics of existing materials, as far as they are available, indicate a very definite falling off in the strength of the material at higher temperatures.

The use of high temperatures has been encouraged recently, as it has enabled the use of higher pressures without reheating the steam. If the wetness in the exhaust is to be kept below a certain maximum—say, 12 per cent.—to prevent excessive corrosion, then it will be possible to raise the pressure with the temperature. By raising the temperature from 800 deg. to 900 deg. Fah., for instance, the pressure could be raised from 430 lb. per square inch g. to 680 lb. per square inch g. The improvement in thermal efficiency of the plant by raising both temperature and pressure would be roughly 8 per cent. for every 100 deg. Fah. increase in temperature, whereas the improvement by raising the temperature only would be one-half—*i.e.*, 4 per cent. for 100 deg. Fah. increase in temperature.

The use of higher temperatures, together with correspondingly higher pressures, as suggested, is seriously handicapped by the variation in the steam temperature which occurs in most boilers, using convection type superheaters, with varying load. The greater the load on the boiler, the higher the superheat. This means that at periods of highest loads the conditions become most severe, a condition which should obviously be avoided if possible.

With higher temperatures, which means higher superheats, this variation of total temperature becomes greater than with moderate steam conditions, because the propor-

tion of heat to be transmitted in the superheater becomes larger and the proportion of heat required to evaporate water becomes gradually smaller. This is shown in Fig. 14 for the condition that feed water is supplied to the boiler at temperatures which are calculated on the basis of four-stage feed-water heating and for the gain due to feed heating being ½ per cent. below the maximum theoretical gain. The temperatures calculated on this basis produce for average conditions of load factor, cost of coal, &c., the maximum economic gain.

The ratio of heat in superheat to heat of evaporation is—

21	per cent. at	..	700	deg. Fah. and	270	lb. per sq. inch g.
28	,,	..	800	,, ,,	430	lb. ,, ,,
37	,,	..	900	,, ,,	680	lb. ,, ,,
50	,,	..	1000	,, ,,	1040	lb. ,, ,,

In view of these conditions and the rapid decrease in creep strength of all materials at higher temperatures, it becomes increasingly more important to provide boiler plant in which the superheat can be automatically controlled. It is suggested that the boiler shown diagrammatically in Fig. 15, which may be called a Multiple Superheater Boiler, meets these conditions, and offers at the same time various other advantages. It retains those parts of the existing boiler which have proved successful and which are essential, such as water-cooled walls, but all water tubes, apart from those exposed to radiation, are eliminated. The necessary convection cooling surface for the gases is obtained by means of superheater tubes, in which the steam is superheated twice, each process being carried out in separate superheaters. Before the steam passes from the first to the second superheater, the steam is cooled in tubes immersed, or partly immersed, in the water in an evaporating drum. The water evaporated in this drum is added to the steam evaporated in the boiler proper, and passed together with it to the first superheater.

The gases pass from the furnace A, which is surrounded by water walls B to a superheater chamber C, which is arranged above the furnace, but is protected from the radiation of the furnace by two or more rows of tubes which form part of the circulation between the back water wall and the boiler drum D.

The desuperheating evaporator is shown at E. The steam from both drums D and E passes to the first superheater, which is shown to be arranged in counter current

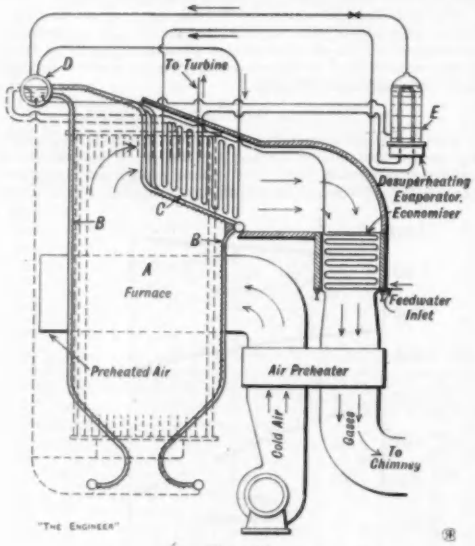


FIG. 15

Multiple Superheater Boiler

with the flue gases, and after being superheated it is led to the cooling tubes arranged within the evaporating drum E. As the pressure on the water side is slightly higher than that on the steam side, the steam is cooled to a temperature higher than saturation temperature, and it is then led to a second superheater which may be arranged in parallel current with the flue gases, in order to keep the temperature of these tubes, which are exposed to the hotter gases, as low as possible. After being superheated to the required temperature, which is automatically controlled, as described later, the steam is supplied to the turbine.

The additional steam supplied by the desuperheating evaporator may be 20 to 40 per cent. of the total steam quantity according to the superheat and pressure used. The maximum amount of heat which may be taken up in the additional superheater is indicated by the cross-hatched area in Fig. 14. These figures are well within the range of possibility and show quite clearly that the multiple superheater can be used to displace the usual convection surface of a boiler, since in practice boiler operation figures have shown that it is possible to transmit to the furnace walls amounts as high as 80 per cent. of the heat of evaporation.

The evaporator tubes may be of the hairpin type, and the separate evaporating drum would be of a design similar to a high-pressure feed heater with the exception that the steam passes through the tubes and the water surrounds the tubes.

Tubes of greatest obtainable length can be used for the construction of this boiler, thus reducing the number of expanded joints to a minimum. The full height of the boiler unit, *i.e.*, from the bottom of the furnace to the drum, is available to maintain natural circulation, and this applies to all the heating surface of the boiler, that is, there are no mixed systems of circulation within this boiler.

The superheater tubes may be of a relatively small diameter, thus reducing the weight of material for a given surface. They may be bent and also made in great lengths so that the number of joints is greatly reduced.

The superheater is conveniently arranged to be accessible for cleaning and adjustment. The final superheat is maintained constant by automatically controlling the active surface in the evaporator—by lowering or raising the water level in the evaporator. This is effected by means of a relatively small throttle valve arranged in the saturated steam pipe from the evaporator, this valve being controlled from a thermostat in the steam pipe after the final superheater. Thus, there is no higher steam temperature obtained in any part of the plant than that intended for normal operation.

The arrangement of economisers, preferably steaming economisers and air heaters, at the back of the boiler, as shown, makes for compactness and simplicity.

The boiler drum itself can be kept smaller as only a portion of the total quantity is evaporated within it. Thus, considerable savings are effected in this part of the installation. Also the number of tubes discharging into the drum is far less than is usually required with existing boilers, so that the strength of the wall of the drum is not reduced to he same extent. The thickness of the wall can, therefore, be reduced, thus further reducing the cost of the drum.

All water tubes are conveniently arranged to enter the drums near the water level, thus minimising the risk of priming to a very large extent while the drum is located in such a manner that it is not exposed to the hot gases. All expanded joints between tubes and the drum and the intermediate headers can be arranged external to the furnace, so that any steam leakages become visible and can be remedied as soon as they occur, and before excessive damage has resulted. As expanded joints are not exposed to high gas temperatures, large differences in temperature between the expanded tube and the headers or the boiler drum are eliminated. Added to this the stresses on the joints are kept to a minimum by the flexibility of the tubes which the arrangement provides. The risk of leakage therefore is reduced to a minimum.

The design of existing types of boilers varies for each particular case, as the surface required in the water tubes and the position of the superheater depends, to a large extent, on the quality of the fuel and the efficiency aimed at, &c. In the new boiler these conditions would not affect the design of the furnace itself, or of the water wall; it would only affect the size of the superheaters and the size of the evaporating drum. These need not be determined with great accuracy, as the additional evaporation is automatically controlled. This boiler is, therefore, also suitable for using different types of fuel, for instance, in cases where oil is used for emergencies, the change-over, from one fuel to another being accomplished without any modification to the plant.

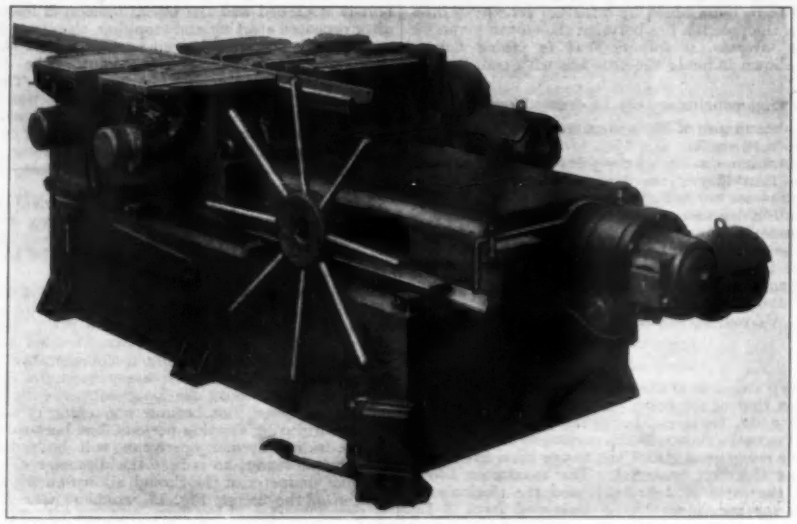
The advantages outlined above are obtained by the use of an additional evaporating drum. The surface required in this drum depends largely on the heat transmission between the superheated steam and the boiling water. This varies with the steam pressure and the steam velocity. The tubes in the evaporating drum can be kept small in diameter, and the tube thickness need not be great, as the difference in pressures on the two sides is small. The extra cost involved in providing this drum is less than the saving resulting in the boiler itself. As the heat transmission increases in almost direct ratio with the steam pressure, this boiler is particularly suitable for extra high pressures; but it is estimated that even for moderate pressures of, say, 400 lb. to 600 lb. per square inch, the cost of this type of boiler would be materially lower than that of the conventional type.

As the steam is being heated and cooled and heated successively, and as the steam is still superheated when cooled, any water carried over from the boiler would have every opportunity to be evaporated before it enters the turbine. Difficulties due to scaling of superheater tubes and consequent overheating, are avoided, as the first superheater, which is supplied with steam from the boiler drum, is exposed to low temperature gases only.

THE TRAINING OF YOUNG AUTOMOBILE ENGINEERS.—The Institution of Automobile Engineers has for some years been giving advice to parents as to how their sons can enter the automobile industry. This practice has been elaborated, and the Institution is now in a position to inform parents as to the exact possibilities of apprenticing their sons in works in their own neighbourhood. No charge is made by the Institution, and parents may consult the staff by appointment on making written application to the Institution of Automobile Engineers, Watergate House, Adelphi, London, W.C. 2.

BUTT WELDING MACHINE

A.E.G., BERLIN, ENGINEERS



Heavy Duty Butt Flash Welding Machines.

EXTENSIVE trials having shown that butt welding is satisfactory for certain purposes and that the quality of the weld may be equal to that of the solid material, the method is now widely adopted in railway works, shipyards, &c., principally for the manufacture of parts which for the sake of mechanical strength were originally worked from solid material, but which now consist of small components welded together electrically. The process affords considerable saving of material and labour, especially in the case of heavy and bulky parts, and the system has proved particularly advantageous in the production of locomotive fire-box rings in two parts, the welding of the ends of rails to crossings and points, the welding of ships' stems, propeller shafts and buffer stems of railway carriages, &c.

The A.E.G. of Berlin, has designed machines in which the clamping device is accessible on all sides and in which the transformer is water cooled. The machines are supplied with a clamping and upsetting device driven by an electric motor, as shown in the accompanying illustrations. The casing consists of steel plates joined together by arc welding, a form of construction which is light, cheap, and extremely strong. The transformer is mounted at the left-hand part of the casing, and is placed in a completely enclosed chamber so that flashed metal or sparks cannot reach it; but at the same time, on the removal of the side covers, it is readily accessible.

The right-hand part of the casing contains the gearing for the upsetting device, whilst the clamping jaws are mounted on top of the casing. The front jaws are fixed and the rear ones movable, each of the latter being driven by a motor placed behind the machine. The upper surfaces of the jaws are smooth and are provided with tapped holes or slots in which special clamping devices can be fastened and can easily be removed.

Each of the motors for the clamping device is switched in by a lever at the side of the fixed jaws, which are fitted with shock absorbers, consisting of strong springs mounted in cylinders which prevent jamming of the motors. Each of the springs is connected with a pressure gauge, which automatically cuts out the motor after the clamping pressure has reached a certain value. Each pressure gauge is provided with an adjustable screw so that the pressure at which the motor is cut out can be adjusted, and a calibration scale is provided so that the pressure may be read in tons. The "burnoff" is done by hand by means of the spoked hand wheel, as it can only be accomplished satisfactorily by the operator. Upsetting, however, is done by switching in the upsetting motor, which is to be seen at the extreme right of the machine, and in order that the switch for this motor may be easily controlled by the operator it is fixed near the spoked wheel. The upsetting device is also provided with a shock absorbing spring and an adjustable pressure gauge similar to those provided for the clamping device. Before welding, the three pressure gauges are adjusted so that the clamping pressure is slightly greater than the upsetting pressure in order to prevent the parts to be welded from sliding in the jaws. A contactor controlled by a foot switch serves for switching in the transformer, whilst a regulating switch is provided at the left-hand part of the casing, and the welding voltage can be regulated in five steps. Machines of this type have been supplied in four sizes, and the principal particulars of each of these machines are given above. Special clamping devices to meet customers' requirements can be supplied.

	Type.			
	HW 80/140.	HWM 100/160.	HWM 130/220.	HWM 300/550.
Electric output—				
Continuous, kVA.. ..	80	100	130	300
Intermittent, kVA ..	140	160	220	550
Welding output, max., sq. in. open length	9·4	15·5	15·5	46·5
No. of weldings per hour at max. cross section ..	4	2	3	—
Net weight, about, tons ..	2·4	5·2	5·3	21·8

Railway and Road Matters.

THE Metropolitan Railway Company has followed the example of the Southern Railway in having joint accountants. Mr. W. M. Ballingall, the present accountant on the Metropolitan, and Mr. F. W. Curtis, are the new joint accountants.

THE London, Midland and Scottish Company is experimenting with some railroad coaches which can run on either the railway or the road. They have two sets of wheels—a flanged wheel for the railway, and a pneumatic-tired for the road, and it is said that the change-over is readily made.

DURING the first three months of the present year the Assistant Inspecting Officers of the Ministry of Transport held 49 inquiries into the more serious accidents to railway servants, of which 18 were fatal cases. It was considered that eight of the men killed met their death by misadventure, seven were due to want of care, and three to no look-out man having been provided to protect the men in their work.

WE greatly regret to hear of the recent death of Mr. Max Weiss, the chief engineer for traction of the administration of the Swiss Federal Railway. Mr. Weiss was the reporter on electric traction for all countries except America at the London International Railway Congress in 1925, and his excellent command of the English language made him a valuable vice-president in Section II.—Locomotives and Rolling Stock—at the meeting in Madrid last May. Members of the Institution of Locomotive Engineers will hear with regret of the death of Mr. Weiss because of the great consideration he showed them at their Summer Meeting in Switzerland last June.

THE Great Western Railway Company has issued some particulars of the Cogload Junction–Taunton–Norton Fitzwarren widening, which was mentioned in our issues of November 29th, 1929, and August 1st last. These show that the down line from Bristol at Cogload Junction will be carried over the Westbury lines by a flying junction. In addition to there being, as we previously intimated, four through lines through Taunton Station, instead of two, there will be seven bay lines. There will be an island platform for the up main and down main lines, which will be 1400ft. long on the up side. The down main side will be 1200ft. long, as will be the up relief and down relief platforms.

IN this column of our issue of May 2nd last we mentioned that at the end of 1929 the London and North-Eastern had 564 engines under, or awaiting, repair; that figure was 60 less than at the end of 1928 and 207 less than at the end of 1927. Six years previously the number was 932, or 368 more than at the end of 1929. Mr. Whitelaw, in giving these figures at the annual meeting on March 7th last, said that it was an indication of the value of up-to-date shops equipped with first-rate machinery. We are led to repeat the above paragraph now because, in the November issue of the *London and North-Eastern Railway Magazine*, there is an article by Mr. Robert A. Thom, the mechanical engineer, Doncaster, showing how the great reduction in the number of locomotives out of service for repairs has been effected.

THE circumstances that contributed to the collision of August 4th—Bank Holiday—on the south side of Preston station, London, Midland and Scottish Railway, were, as related in this column of our issue of August 22nd, inquired into, on behalf of the Ministry of Transport, by Lieut.-Colonel Anderson. In this case an excursion train for Leeds was standing at the starting signal for the up slow line at Ribble Sidings box, when it was overlooked and a following train for Birmingham was accepted. The home and starting signals for the latter were put to "clear" and, therefore, the Leeds train began to move forward, and directly afterwards it was run into by the Birmingham train. The signalman admitted his error, and the driver was excused for not seeing the tail lamp of the Leeds train by the fact that it was placed low down and on the right, or fireman's, side of the corridor gangway, and the driver would be looking for the starting signal which had the two fast lines intervening between it and the up slow line. There is track circuit in the rear of the up home signals and its extension up to the starting signals is recommended.

THE Institution of Railway Signal Engineers held its Summer Meeting of 1929 in Holland, on which occasion Mr. G. J. de Vos, the Chief Signal and Telegraph Engineer of the Netherlands State Railways, undertook to pay a visit to England and to read a paper before the Institution on "Railway Signalling in Holland," which promise was redeemed yesterday—Thursday. British railway practices, as a consequence of the large amount of capital from this country that was invested in the railways of Holland, particularly in the Dutch Rhenish Railways, have had a great influence, *e.g.*, in the design of the locomotives, and that is seen in the use of the semaphore instead of the disc signal. There are, however, many important variations, but all these have the advantage of consistency. The arms of home and starting signals have a circle at the outer end, whilst attention is drawn to the greater importance of junction stop signals by their having a fish-tailed arm. Distant signal arms are not fish-tailed, as in England, but are square-ended with no circle. Starting signals have their own distant signals, which is a great advantage over the British system at stations, inasmuch as we require the starting signal as well as the home signal to be "off" before the distant can be put to "clear," and, therefore, on busy sections stopping trains find the distant "on" although there is a clear run into the station. Stop signal arms in Holland move from the horizontal upwards to an angle of 45 deg., and the red light is changed to white; the arm of a distant is normally inclined downwards and gives a green light, and when put to "clear" it is raised to 45 deg. above horizontal and has a white light. A junction distant signal has two arms whose indications can be varied to show either that the stop signals are on, or that the signal for the more important line is "off," or that for the less important. The night indications for this signal are given by either two green lights, two white lights, or a white and a green light.

Notes and Memoranda.

ACCORDING to the report to the Ministry of Transport on accidents on the railways of Great Britain during 1929, the number of derailments remained remarkably uniform, while the progressive decrease in respect of broken rails and axles was maintained. Cases of failure of couplings increased, the chief liability to failure being weakness of the draw gear.

WHAT is claimed to be the largest motor generator set ever built for supplying power for motors driving a blooming mill is being tested in Westinghouse Electric and Manufacturing Company's works at East Pittsburgh, Pa. This 9000 kW set consists of three 3000 kW generators and a 6500 H.P. induction motor. It will furnish the power for two 5000 H.P. double-unit reversing motors for twin drive. The fly-wheel of the set is 15ft. diameter and weighs over 80 tons.

WHAT is believed to be a record in the burning of pulverised coal was made recently in the power plant of the West Virginia Pulp and Paper Company's mill at Tyrone, Pa., when a Riley flare-type burner operated at sufficient capacity to liberate 140,000,000 B.Th.U. per hour. The burner is used to fire an 8460 square feet Springfield boiler equipped with water walls which operates at a pressure of 600 lb. At the time the record was made, the boiler was generating approximately 100,000 lb. of steam an hour, or about 420 per cent. of its rating. The temperature of the preheated air at this rating was 550 deg. Fah., and the CO_2 was 15·2 per cent.

CRUCIBLES built up from a number of tongued and grooved sections of tile joined by cement for use in induction furnaces for the melting of cast iron and special alloys are announced by the Babcock and Wilcox Company, New York. These crucibles are set into the furnace coil and the intermediate space is packed with mica or asbestos paper. The crucibles have a rammed lining of cement, and, consequently, do not come in direct contact with the metal. By repairing or renewing the cement lining every ten to fifteen melts, it is possible to obtain 150 to 200 melts from one crucible, according to the manufacturer. The refractory material from which the crucibles are made is claimed to have a low coefficient of expansion, high strength and to be free from shrinkage.

AT the meeting of the Society of Glass Technology, held in Sheffield on October 15th, a paper on "The Effect of Re-melting on the Properties of Glass," was read by Professor W. E. S. Turner. In his opening remarks Professor Turner referred to the stimulating discussions on the use of cullet which had taken place at earlier meetings of the Society. Investigations into the subject had been proceeding at Sheffield for some years, glass being melted and re-melted many times, the effect upon the working properties being reported by an experienced glass-worker drawing rod. It was concluded from these practical tests that as the proportion of cullet to the batch was increased, and also when cullet itself was repeatedly melted, progressive changes took place in the glass properties. This view was confirmed by others engaged in commercial glass-making, but there was no means of direct corroboration in accurate laboratory work.

POLE top or cross-arm fires on electric transmission systems operating at tensions in excess of 6000 volts may be successfully eliminated by the application of a special aluminium paint to pole tops and cross-arms. Current as small as 1 milliampère at potentials as low as 6000 volts will, under suitable conditions of concentration of current and dryness of timber, char the surface of pole tops or cross-arms and ultimately cause them to burst into flame. Small currents of this magnitude will leak over sound porcelain insulators of quite safe normal flash-over value when light rains occur or misty conditions exist after periods of prolonged dry weather, particularly in a salt-laden atmosphere. Such conditions, however, are taken care of when the poles and cross-arms are painted with aluminium paint. The composition of the paint is 1 gallon of aluminium paint, 1 gallon of grey paint, 4 gallons of linseed oil, and 21 lb. of plumbago.

THE Dominion of Canada Bureau of Statistics, in a report just received by the Acting High Commissioner for Canada in London, estimates the production of wire and wire fencing in Canada in 1929 to have totalled 311,078,744 lb. of plain wire; 84,579,260 lb. of galvanised wire; 12,414,563 lb. of coated wire other than galvanised; 25,318,705 lb. of barbed wire; and 57,962,003 lb. of fencing wire. Of the twenty-three plants manufacturing wire, twelve were situated in Ontario, six in Quebec, two in New Brunswick, two in British Columbia, and one in Nova Scotia. Fourteen factories made plain wire, twelve made galvanised wire, eight made other coated wire, eight made wire fencing, and six reported an output of barbed wire. These twenty-three plants had an operating capital of 30,304,973 dollars, and afforded employment to a monthly average of 3088 persons, who received 3,853,807 dollars in wages. Their purchased materials cost 7,260,163 dollars, and the wire or wire fencing items given above formed about one-half of their sales, which amounted in all to 16,892,761 dollars.

IN the course of a brief historical survey, Mr. H. Marryat, lecturing on "Luminous Electric Tubes" before the Junior Institution of Engineers on November 7th, stated that the present luminous tubes containing neon, helium and other rare gases so much in evidence in our cities for advertising and other purposes, were the lineal descendants of the Geissler tube, the scientific toy of more than fifty years ago. For a great many years practically no advance had been made in the application of the principle, but the notable discoveries of Professor Crookes, Sir William Ramsay and other scientists in connection with the separation of argon, helium, neon and other rare gases had provided the means for putting the exhausted tube containing various quantities of these gases to commercial and practical uses for illumination purposes, and such was the present rate of progress in overcoming certain inherent difficulties in manufacture and operation that he predicted the time was undoubtedly coming when this system of illumination would supersede all others, mainly owing to its fundamental efficiency and its ready application to practically all kinds of illumination.

Miscellanea.

IN preparation for the building of the new proposed Cunard liner, some considerable extensions are being made at one of the berths of John Brown and Co., Ltd., at Clydebank. The berth itself is being lengthened, the cranes are being repositioned, and the gantries are being heightened.

THERE has been placed on exhibition in the mining collection of the Royal Scottish Museum a specimen of one of the largest winding ropes made. It has been prepared and presented by the makers, Bruntons, of Musselburgh. The rope, which is nearly 8in. in circumference, has a breaking strength of about 250 tons, and was made for use in a copper mine in South Africa.

IN the Merrickville Low Level Pumping Station in Australia there is a mixed equipment of steam, electric and oil driven pumps. The engineer in charge of the station reports that, with coal at 28s. per ton, the steam engine will pump 5,000,000 gallons for £3 1s. 10d. The same service costs £7 1s. 6d. with electric current at 1¼d. per unit. The 120 H.P. Paxman oil engine, using crude oil at 103s. per ton, does the same work for £1 8s. 7d.

A STEEL deoxidiser placed on the market by the Vanadium Corporation, of America—120, Broadway, New York—has been named "Alsifer." It is claimed for this ferro-alloy that it is free from carbon and analyses approximately as follows:—Al, 20 per cent.; Si, 40 per cent., and Fe, 40 per cent. It has a low melting temperature and is rapidly and completely taken up by the molten steel. Directions for its use are set out in a folder issued by the corporation.

FOR the development of manufacturing enterprises in Kiangsu, the industrial centre of Wusih was selected some time ago by the Chinese National Reconstruction Commission as the most suitable place for the opening of a large electric power generating plant in Southern Kiangsu. Surveys have been completed and the situation of the works decided upon. Construction is expected to be started within the current year. Arrangements will also be made for the establishment of a similar power plant on the eastern shore of the Hung-tse Lake in Northern Kiangsu.

CONFIRMATION is now forthcoming of the reported discovery of a large coalfield in Southern Tanganyika, said to be the largest field in Africa. The reports of experts, quoted by the *S.A. Mining and Engineering Journal*, state that investigations have proved the existence of hundreds of millions of tons of bituminous coal worthy of immediate exploitation. The outcrop is exposed for a distance of 12 miles. The economic potentialities of the field are diminished by the fact that it is 400 miles from the main railway line of Tanganyika, though it is near the northern end of Lake Nyasa.

A LIST published by the Waterless Gasholder Company, Ltd., shows the progress made in the installation of waterless gasholders from 1918 to September, 1930. In 1918 there were six holders of this type, with a capacity of 3,100,000 cubic feet. To-day, there are either installed or on order 226 holders having a total capacity of over 604 million cubic feet, and ranging in size from under 50,000 cubic feet to 20 million cubic feet. As regards the countries where they have been adopted, Germany leads with 92, the United States comes next with 43, while in Great Britain there are 25, in France 19 and in Holland 10.

A VERY depressing view of the situation in the United States was expressed recently by Mr. Virgil Jordan, an American economist, in an address before the National Electrical Manufacturers' Association. He took a number of the leading financiers to task for suggesting that the position could be improved by lowering the standard of living, and said that any movement towards deflation required vigilant control. In his view it was probable that the country was in for an unduly prolonged period of business stagnation and political unrest unless business leadership in every industry mobilised the constructive forces of individual initiative to check the process. Mr. Jordan discounted the prophecies of an early recovery of business. There were no signs of early improvement, and even the expectations of recovery next spring were none too sure unless aggressive effort was brought to bear very soon.

THE Secretary for Mines announces that the Metalliferous Mines Advisory Committee has appointed two sub-committees to inquire into the possibilities of developing, or of reviving, the working of metalliferous and associated deposits in Great Britain. The committees, which are under the chairmanship of Mr. J. J. Burton, O.B.E., J.P., are constituted as follows:—For non-ferrous mining: Messrs. W. H. Bennett, Clive Cookson, F. Merricks, C.B.E., R. A. Thomas, J.P., and Anthony Wilson, J.P. For iron ore mining: Messrs. W. W. Casson, H. Dack, J.P., T. Gavan-Duffy, A. Hibbert, D.S.O., M.C., S. J. Lloyd, J.P., H. Nixon, J.P., W. Sherwood, R. E. Westwood, J.P., and Professor Henry Louis, D.Sc. Mr. A. M. Clegg will act as Secretary to the committees, and all communications on the subject should be addressed to him at the Mines Department, Dean Stanley-street, Westminster, London, S.W. 1.

THE directors of the Northallerton Electric Light Company are reported to have decided to sell the Northallerton Electricity Works to the Cleveland and South Durham Electric Light and Power Company for £16,500. This sale will have to be confirmed by the shareholders, but this is only a formal matter, as the largest holders of shares in the Northallerton Company are in favour of the proposal. By this purchase the Cleveland Company will control all the electricity producing plants in the southern portion of the North Riding, and it is the intention of the company to establish a large distributing centre at Northallerton, from which all the towns and villages in this part of the North Riding will be supplied with current for light and power purposes at a cheaper rate than at present. The charges for electricity in this area are much in excess of the amounts charged per unit in the adjoining towns of Darlington, Stockton, and Middlesbrough.

LARGE DRILLING MACHINE FOR STEEL COLUMNS AND GIRDERS

THE STRUCTURAL SERVICE COMPANY, CHICAGO, ENGINEERS

(*For description see page 548.*)

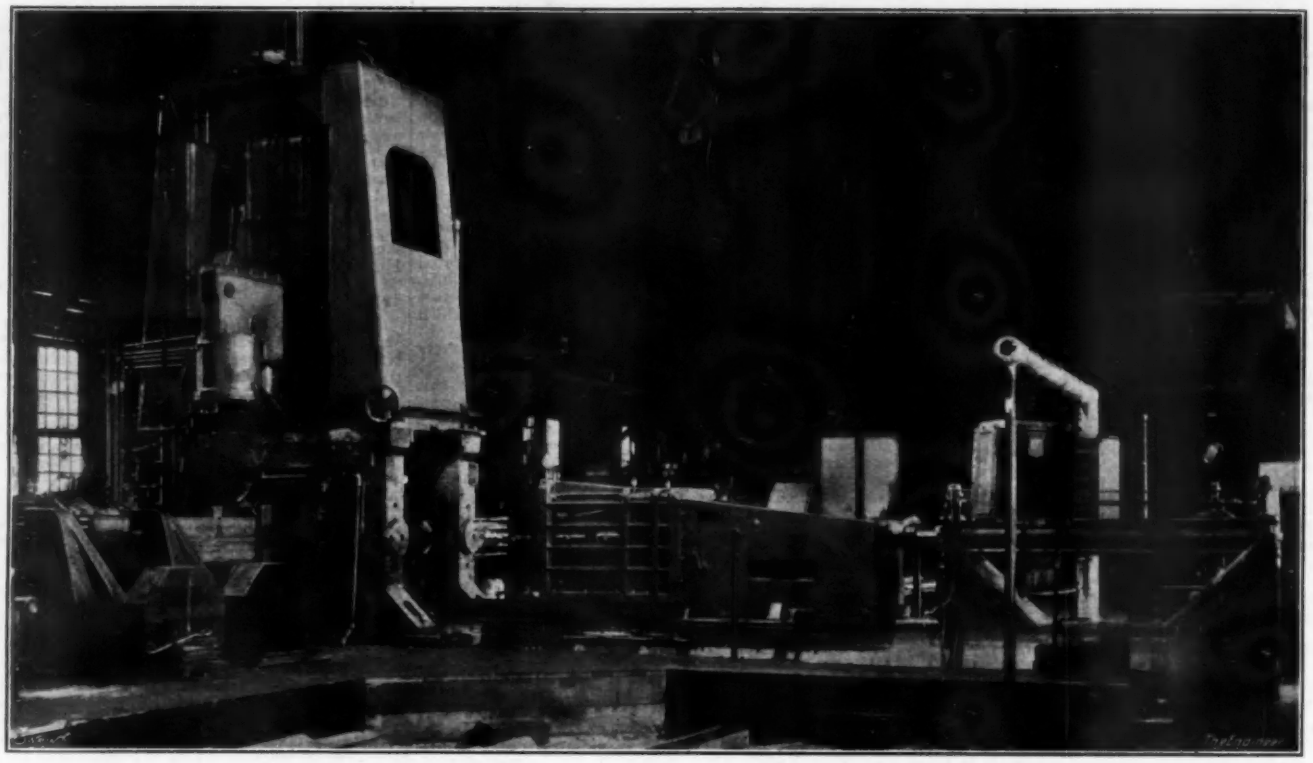


FIG. 1—VIEW FROM ASSEMBLING TABLE END, SHOWING HYDRAULIC OPERATING CYLINDER

FIG. 2—VIEW SHOWING DRILL CARRIAGE LOWERED ON TO WORK

The Engineer
Annual Subscription Rates
(Including postal charges).

Subscriptions will be accepted by the Publisher direct or through a newsagent at the rates and in the currencies stated below :—

BRITISH ISLES	.. ..	£3	5	0	
CANADA	.. .. ..	£3	3	0	Thick Paper edition.
		£2	18	6	Thin Paper edition.
ABROAD	.. .. ..	£3	7	6	Thick Paper edition.
(except Canada)		£3	3	0	Thin Paper edition.

AFRICA	Central News Agency. All Branches
* £3 7s. 6d.	CAPE TOWN : Wm. Dawson and Sons, Ltd.,
† £3 3s. 0d.	29–31, Long-street (Box 489)
	JOHANNESBURG : C. Juta and Co.
ARGENTINE ..	BUENOS AIRES : Mitchell's Book Store, 576,
* £3 7s. 6d.	Cangallo
† £3 3s. 0d.	
AUSTRALIA ..	Gordon and Gotch (Australasia), Ltd. All
* £3 7s. 6d.	Branches
† £3 3s. 0d.	MELBOURNE : Robertson and Mullens,
	Elizabeth-street
BELGIUM ..	BRUXELLES : W. H. Smith and Son, 78–80,
* Fr. 590	Rue du Marché-aux-Herbes
† Fr. 550	
CANADA	American News Company, Ltd. All Branches
* $15·25	MONTREAL : Gordon and Gotch, Ltd., 334,
† $14·25	Notre Dame-street, W.
	TORONTO : Wm. Dawson and Sons, Ltd., 87,
	Queen-street East
	TORONTO : Gordon and Gotch, Ltd., 81,
	Queen-street West
CEYLON	COLOMBO : Wijayartna and Co.
* Rs. 44·5	
† Rs. 41·5	
CHINA	HONG KONG : Kelly and Walsh, Ltd.
* $37	SHANGHAI : Kelly and Walsh, Ltd.
† $34·5	
EGYPT	CAIRO : Express Book and Stationery Store,
* £3 7s. 6d. (Pt. 330)	9, Chareh Maghrabi
† £3 3s. 0d. (Pt. 308)	
FINLAND ..	HELSINGFORS : Akademiska Bokhandeln,
* M. 650	Alexandersgatan, 7
† M. 605	
FRANCE	PARIS : Boyveau and Chevillet, Rue de la
* Fr. 418	Banque, 22
† Fr. 390	PARIS : Librairie Berger-Leverault, 229, Bld.
	St. Germain
	PARIS : Brentano's, 37, Av. de l'Opera
	PARIS : Dunod, 92, Rue Bonaparte
	PARIS : W. H. Smith and Son, 248, Rue de
	Rivoli
GERMANY ..	BERLIN–LICHTERFELDE–WEST : H. Her-
* R. mks. 70·00	manns, Dahlemer Strasse 64 A
† R. mks. 65·00	WESTERN GERMANY : Fritz Rehfus, Blumen-
	thalstrasse 10, Cologne
	LEIPZIG : K. W. Hiersemann, Konigstrasse 29
HOLLAND ..	ROTTERDAM : Hector's Boekhandel, Noord-
* Fl. 41·00 ..	blaak 59
† Fl. 38·00	ROTTERDAM : Techn. Boekhandel, "Plan C,"
	Gelderschestraat 4
INDIA	BOMBAY : Thacker and Co., Ltd.
* Rs. 45	CALCUTTA : Thacker, Spink and Co.
† Rs. 42	
ITALY	MILAN : Ulrico Hoepli
* Lire 300	ROME : Maglioni and Strini, 307, Corso
† Lire 280	ROME : Fratelli Treves, Corso Umberto I, 174
	ROME : Fratelli Bocca
	TURIN : Rosenberg and Sellier, v. Maria
	Vittoria 18, and their Branches at Naples
	and Rome
JAPAN	Maruzen Co. All Branches
* £3 7s. 6d.	
† £3 3s. 0d.	
JAMAICA	KINGSTON : Educational Supply Co.
* £3 7s. 6d.	
† £3 3s. 0d.	
NEW ZEALAND	AUCKLAND : Whitcombe and Tombs, Ltd.
* £3 7s. 6d.	Gordon and Gotch, Ltd. All Branches
† £3 3s. 0d.	NAPIER : J. Wilson Craig and Co.
RUSSIA	LENINGRAD : Mezhdunarodnaya Kniga, Pros-
* £3 7s. 6d.	pect Volodarsky, 53 A
† £3 3s. 0d.	MOSCOW : "Litisdat," Kousnetsky Most, 5-15
STRAITS SETTLEMENTS	—SINGAPORE : Kelly and Walsh,
* $29·25	Ltd.
† $27·25	
SWEDEN	STOCKHOLM : A/B Wennergrens Journal-
* Kr. 61·00	expedition, Stockholm 1
† Kr. 57·00	STOCKHOLM : A/B C. E. Fritzes Kungl.,
	Hofbokhandel, Fredsgatan, 2
SWITZERLAND	BERNE : Joh. William De Groot, Laupenstr. 5
* Fr. 85·20	ZURICH : Rosa Leibowicz, 4, Ankerstr.
† Fr. 79·50	
UNITED STATES	International News Co., 131, Varick-street,
OF AMERICA	New York, N.Y., and all Branches
* $16·40	Entered as second-class matter at the Post Office,
† $15·25	New York, N.Y., December 12th, 1896, under the
	Act of March 3rd, 1879 (Section 397, P.L. & R.)

* *Thick Paper.* † *Thin Paper.*

These rates are liable to alteration if exchange fluctuations require it.

*** READING CASES, *to hold two copies of* THE ENGINEER, *cloth sides and leather backs, can now be supplied at 4s. 9d. each, 5s. 3d. post free.*

"THE METALLURGIST."

This Supplement, which deals with the Science and Practice of Metallurgy, both ferrous and non-ferrous, is published free with the last issue of THE ENGINEER in each calendar month.

ADVERTISEMENTS.

The charge for Classified Advertisements is 1/- per line up to one inch —minimum charge 4/-; those occupying one inch or more at the rate of 12/- per inch. Orders must be accompanied by a remittance. The rates for Displayed Advertisements will be forwarded on application. Classified Advertisements cannot be inserted unless delivered before TWO o'clock on Thursday afternoon (the day before publication).

Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

THE ENGINEER DIRECTORY.

This Directory, which is published annually in the interests of advertisers in THE ENGINEER, may be obtained free of charge on application to the Publisher.

Postal Address, 28, Essex-street, Strand, London, W.C. 2.
Teleg. Address, "Engineer Newspaper, Estrand, London."
Tel.: Central 6565 (8 Lines).

By arrangement with Reuter's Engineering Service, **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

Contents.

THE ENGINEER, November 14th, 1930.

	PAGE
A SEVEN-DAY JOURNAL	529
THE HEATING AND DRYING OF GRANULAR MATERIAL BY CONVECTION. No. II. (Illus.)	530
THE MACHINERY OF THE EARTH	532
AMERICAN ENGINEERING NEWS	534
THE "LION" LOCOMOTIVE. (Illus.)	535
METROPOLITAN WATER BOARD : ANNUAL REPORT	536
LETTERS TO THE EDITOR—	
Motor Cycle Engineering	536
"Creep" Designing	537
Airships and Tropical Climates	537
HIGH-PRESSURE GAS REACTIONS	537
CONGRESS FOR MECHANICAL ENGINEERING	537
B.E.S.A. SPECIFICATIONS	537
SOME CONSIDERATIONS AFFECTING FUTURE DEVELOPMENT OF THE STEAM CYCLE. No. II. (Illus.)	538
HEAVY DUTY BUTT FLASH WELDING MACHINES. (Illus.)	540
RAILWAY AND ROAD MATTERS	541
NOTES AND MEMORANDA	541
MISCELLANEA	541
LEADING ARTICLES—	
The Machinery of the Earth	543
Technological Unemployment	544
FUTURE DEVELOPMENT OF THE STEAM CYCLE	544
OBITUARY—E. R. Matthews—H. M. MacKay	545
NEW MINING ELECTRICAL CONTROL GEAR. (Illus.)	546
THE EUSTON BUFFER STOP COLLISION	547
LARGE DRILLING MACHINE FOR STEEL COLUMNS AND GIRDERS. (Illus.)	548
A BRAKE TESTING MACHINE. (Illus.)	549
SIXTY YEARS AGO	549
THE BATTERSEA POWER STATION. (Illus.)	550
SOUTH AFRICAN ENGINEERING NOTES	550
PROVINCIAL LETTERS—	
The Midlands and Staffordshire	551
Lancashire	551
Sheffield	551
North of England	552
Scotland	552
Wales and Adjoining Counties	553
PERSONAL AND BUSINESS ANNOUNCEMENTS	553
CONTRACTS	553
CATALOGUES	553
CURRENT PRICES FOR METALS AND FUELS	554
FRENCH ENGINEERING NOTES	555
BRITISH PATENT SPECIFICATIONS. (Illus.)	555
FORTHCOMING ENGAGEMENTS	556

NOTICES TO READERS.

*** *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

*** *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.*

THE ENGINEER.

VOL. CL No. 3905

NOVEMBER 14, 1930.

The Machinery of the Earth.

IN February last year Professor Eddington, in the course of his Thomas Hawksley Lecture, took the members of the Institution of Mechanical Engineers to the stars and invited them to contemplate the amazing forces and conditions which modern research has discovered within them. In spite of the scientific eminence of the lecturer and the brilliance of his exposition, his audience was, we think, left on the whole with a strong feeling of unreality concerning the universe external to the earth. It is difficult, if not impossible, for most of us to accept as realities temperatures of 40,000,000 deg. Cent., pressures of 100,000 million atmospheres and distances of 20,000 light years. Our minds, earth-bound, can form little or no conception of matter 60,000 times as dense as water, of matter having a negative specific heat, or, again, of matter which is simultaneously a gas and a crystal. These were some of the wonders of which Professor Eddington had to tell. They are benumbing to human understanding in the ordinary sense. They pass far beyond our every-day conception, and only in terms of mathematical symbols can we express any understanding of the universe as revealed by the studies of the astro-physicist. Outside the earth, Professor Eddington told us, Dame Nature is no "bustling engineer," but a "serene mathematician." Having been instructed concerning the machinery of the stars, it was more than fitting that the Institution should be told something about the machinery of the earth. There were doubtlessly many who expected to hear last Friday evening from Professor Gregory, as a geologist, a continuation of the sublime and stupendous story begun by Professor Eddington, as an astronomer. It must almost have been a disappointment to them to find the lecturer, in his charmingly quiet and convincing manner, giving to the earth a character which can only be described as mundane. Dame Nature, so far as the world we inhabit is concerned, is no serene mathematician, but, out and out, an engineer, working with forces and matter of the same order and kind as those with which human engineers are on familiar terms.

For well over a hundred years, substantially since the days of James Hutton and the foundation of the Geological Society, geologists have pursued their studies in the cardinal belief that the forces and agencies which moulded the earth to its present form were identical in kind and of the same order of magnitude as the corresponding forces and agencies which they can see at work to-day. The world, they hold, has been brought to its existing state by slow denudation and slow upheaval, supplemented by earthquakes and volcanic eruptions. In modern geology "vast cataclysms of Nature" are not admissible. There, nevertheless, remains ample room in the ambit of the science for facts and figures of stupendous significance and effect. It is, indeed, actually because cataclysmatic action is debarred from consideration that the most astounding figure of all concerned with the earth—its age—can be estimated with any show of probability. If the possibility is to be admitted that at some past period of the earth's history forces and agencies of which we have no experience were in action, or that the forces and agencies were of the known kind, but vastly different in their activity, then it becomes futile to attempt any calculation of the age of the earth by any method. This grand hypothesis of uniformity as opposed to cataclysmatic action, after a hundred years, continues to receive support from observed facts. Evidence is available, as Professor Gregory told his audience, which shows that since the beginning of geological time the earth's climate has been on the average similar to what it is to-day. There have been local variations, but on the whole the warmth received from the sun, the precipitation of rain, the strength of the winds, the activity of volcanoes, and other agencies and forces have, almost since the birth of the world, been of the same order as they are now. The earth, in short, is a prosaically mundane body, and always has been. It is mundane on its surface, and, so it would seem, equally mundane in its interior. There is no geological evidence for the existence of celestial temperatures within the earth. From the observed rate at which temperature increases in deep mines, the earth at its centre ought to be at about 400,000 deg. Fah., a chilly temperature compared with that of the stars, but still one sufficiently above our common experience to be classed as extra-mundal. The method of calculating this central temperaure is, however, on the face of it, so assumptive that no surprise is occasioned by the fact that it cannot be sustained. Geology offers no actual evidence of a temperature at the earth's centre of more than a few thousand degrees, say, 5000 deg. Fah. That temperature is within what man can command. It is well inside the range which we may call mundane. So, too, as regards the composition of the earth. The evidence derived from a study of meteorites, and independently from a study of the propagation of earthquake waves, suggests or proves that our globe consists of a relatively thin stony crust overlying a thick shell of solid nickel-iron, within which there is a fluid core of the same metals. The fluid core has no such density as that which, according to Professor Eddington, exists in the stars. It is under compression, but its specific gravity, it seems, is only about 12. That figure is quite comprehensible by man. It is actually less than the specific gravity of mercury, tungsten, and platinum, and is roughly only about half as much again as the specific gravity of nickel and iron as known to us on the earth's surface. The world is mundane, and so, too, are the only other fragments of the universe with which we can make direct contact, the meteorites which fall in immense numbers annually on our globe. They are of two kinds, stony and metallic and have never been found to contain any element unknown on the earth. The stony meteorites are chemically and petrologically identical with the matter in the stony crust of the earth. The metallic meteorites are of iron-nickel, like the earth's interior.

Geologically, the earth is, as we have said, in all respects mundane. Yet astronomically, as Professor Eddington told us eighteen months ago, it is abnormal. Normal matter is to be found only in the stars. The form and conditions in and under which matter is presented to the inhabitants of the world are from the standpoint of astro-physics entirely exceptional and unique. In his recently published book, "The Mysterious Universe," Sir James Jeans dismisses the possibility of the universe having been planned by a biologist or an engineer. The Great Architect, he says, appears as a pure mathematician. It is the same thought, in different words, as that uttered by Professor Eddington. How are we to make it square with the insistent fact of geology that the earth is

mundane? Shall we say that of all the universe, the earth—and the meteorites—is the only portion that was created by an engineer and not by a pure mathematician? The question is a challenging one. Earth-bound man, using instruments of earthly materials, has sought to explore the constitution and conditions of the firmament beyond his direct reach and examination. He finds it, or thinks he finds it, inconceivably, inexplicably different from the earth. Is it possible that he is deceiving himself and that with the aid of earthly instruments the astro-physicist cannot, and never will, arrive at a true understanding of the universe outside the earth? Once before, if there be truth in the Theory of Relativity, science went badly astray in applying earthly instruments to the measurement of a cosmical subject. It is at least conceivable that the results recorded by the astro-physicist, violently discordant as they are with the results reported by the geologist, demanding as they do the granting to the earth of a wholly exceptional position in the scheme of the universe, may be merely the inevitable outcome of his methods and means, and that the truth lies nearer to a harmony of Nature everywhere than current beliefs suggest.

Technological Unemployment.

"Technological Unemployment" is a term more frequently heard in the United States than in this country. It is one of those loose but convenient expressions which may almost be regarded as scientific slang. It means that kind of unemployment which results from technical progress. If musicians are thrown out of work because the "talkie" houses receive "radio" music, they become technologically unemployed; if a coal mine gets rid of men because the mechanical coal cutter has rendered them unnecessary, that also is technological unemployment. Broadly speaking, we may say that the term is used when, owing to some improvement of a technical character, whether it be proper to the industry or not, labour is displaced. In other words, "Technological Unemployment"—there is a sumptuousness about the words that almost robs them of their bitterness—is what we call here with less comfortable euphony "industrial displacement."

The mere fact that a term of the kind should be in currency is a tacit acknowledgment of the existence of the condition it describes. Years ago no one would have listened patiently to a suggestion that such a thing could happen. It was held, with complete justness, that every technological improvement caused an increase of employment; never a decrease. A temporary displacement of labour *might* take place, but actual unemployment never resulted. Every new device invented by the technician, every new method introduced by the application of science, led at once and quickly to reduction in price and an increased demand for the products of the industry affected. Hence employment increased. The working people did not see things in that light, but as a matter of actual fact, the inventor was their great benefactor. He increased at one and the same time the number of people employed, the wages they received, and the number of commodities they could enjoy. It would be fruitless to deny that circumstances have changed and that innovations may nowadays have the opposite effects. But it would be a mistake to regard this result as sudden and unexpected. It has been coming upon the world in a beneficent form for years. Every technological improvement has sooner or later led to the reduction of hours of labour, and in that limited sense has caused partial unemployment, or—to put it the other way round—has obviated the necessity for engaging men. The twelve-hour day fell to the nine, the nine to the eight, because improvement of processes accelerated output. How much further will the process go? The main thing that holds up the five-day week is the reduction of the "load factor" of the factory. There is talk already of a three-day week in America. It must come, sooner or later, unless the world will accept one of two alternatives. Either it must give up technological development or it must limit the number of factories.

Here we are on the horns of a very desperate dilemma. If we call a halt to technological progress, if we so order our works that they shall give plenty of employment—that is to say, if we regard the giving of employment as the prime business of factories—we must sacrifice the unquestionable advantages in reduction of price which result from quantity production by accelerated methods. If, on the other hand, we decide not to forfeit the manifest advantages of technological improvements, if we decide to push rationalisation to its logical limit—as is now happening in the shipyards—we must inevitably cause "technological unemployment." The capacity for world production of commodities has not nearly reached its limit. The processes of to-day are several times as rapid as those of the past. But they are still far from asymtotic. The future, if unhindered, will see our present state of production multiplied, and at the same time it will witness the industrialisation of many nations which are now agricultural or indefinite. Not the finest selling organisation in the universe can prevent the rate of production exceeding the possibility of consumption, and we shall be forced to reduce the hours of labour in order to give employment. The fact—sometimes cited—that the best-managed, best-organised firms may be working overtime whilst others have little or nothing to do proves rather than disproves the conclusion. If all were up to the level of the highest, there would not be enough work for any one of them. This is one, perhaps the greatest, of the fundamental problems of unemployment.

Future Development of the Steam Cycle.

A meeting of the North-Western Branch of the Institution of Mechanical Engineers was held at the College of Technology, Manchester, on Thursday, November 6th, at which members of the North-Western Section of the Institution of Electrical Engineers and of the Manchester Association of Engineers were present by invitation. There was a very large attendance to hear Mr. K. Baumann read an abstract of his paper on "Some Considerations Affecting the Future Development of the Steam Cycle," the first portion of which was published in The Engineer last week, and the second portion this week on page 538. In the absence abroad of Mr. H. L. Guy, Chairman of the Branch, Professor Dempster Smith, Vice-chairman, presided.

The author's abstract was followed by an interesting discussion, and in opening it, Professor Dempster Smith said the paper would clarify many previously cloudy issues, and would point the way to the next steps in power plant development. In many places the author had indicated where new knowledge was required and where research should be directed to that end. Professor Dempster Smith commended to headquarters the question of the possibility of such research being undertaken by the Institution.

Dr. J. W. Jenkin, the first speaker, said he was in close touch with the majority of the steel tube makers of the country, and from his rather biassed point of view, therefore, he felt that the emphasis on creep stresses did not cover all the ground. The need for materials having greater resistance to creep was generally recognised, but the interrelated factor of resistance to attack by flue gases seemed to have been neglected by the author. The question of scaling was a very serious one, for reduction in the wall thickness inevitably increased the stress in the tube wall, with the risk of exceeding the permissible rate of creep.

Mr. Carey said that Mr. Baumann appeared to give little attention to the question of the stresses which were imposed on joints by the extension of the pipes. But there were two factors in that connection which had to be remembered. One was that while the pipes were assuming their final figuration there would be certain elastic stresses which would tend to separate the joint surfaces, and the second was that it was very difficult to arrange all the pipes so that each range was between two perfectly rigid anchorages. It inevitably arose before the range of pipes was completed, that some thin joint anchorages had to be introduced, and that meant that one set of pipes might influence the other. If they had two ranges of pipes and the steam was shut off one range and left on the other, the stresses in the hot range would be entirely different from what it would be if both ranges were hot. In designing joints for 450 deg. Cent., said Mr. Carey, they had made allowance for that. He did not know whether they had made too much allowance or not, but certainly they had made as rigid flanges as were possible so as to maintain a great pressure at the joint surfaces. It was very largely on that account that they did not adopt the loose type of flange, because the backing obtained from the composite flange gave a greater rigidity and enabled them to keep a greater pressure on the joint. Before they put those flanges into service they tried one of the vertical joints at the working pressure, which was something like 800 lb., and at 500 deg. Cent., for a matter of 6000 hours. They were also able during that test to keep a bending moment which was equivalent to 2 tons per square inch in the wall of the pipe, and they had had no trouble so far in service, but they still had a certain amount of anxiety as to what the eventual effect would be on the joints. He could not but think that a boiler such as Mr. Baumann had proposed was one which was intended to work on feed water which was 100 per cent. pure. With 5 per cent. make-up or even smaller fractions of relatively impure water, he wondered how long the heat transfer coefficients would continue to be obtained. He felt that the use of superheater tubes to extract the steam from the flue gases was probably a step in the right direction. It was only in that way that they were able to get over the chemical troubles which inevitably arose in a feed water which was very frequently far from pure. He thought it might be almost better to continue Mr. Baumann's idea a little further and give some further consideration to the Loeffler type of boiler which was used on the Continent. There, all the heat was extracted from the gases by means of circulating superheated steam.

Dr. Inglis thought that the method employed at present by a great many people, which was merely to adopt the ordinary elastic theories and substitute, instead of the yield point, the requisite creep value, had very little value. Mr. Baumann gave for superheated tubes a creep rate of 10^{-6}in. per inch per hour. That rate seemed to him to allow a very small factor of safety on the stresses actually causing failure. If high creep rates were to be allowed the stresses in the material must be examined. He was struck by the very low figures which were given for certain rates of creep. His own tests carried out on 0·2 carbon steel had given a figure of 6·5 tons as a stress giving that particular rate of creep. The difference could not be accounted for by the difference in carbon content. It was rather interesting to know that in Dr. Hatfield's recent paper he had given a figure of 6 for his time yield, which he advised engineers to use as a basis for design for mild steel at 450 deg. The values at 750 deg. and 800 deg. Fah. were surprisingly low, and, he thought, were definitely lower than those which previous investigators had given. Turning to the creep of the nickel-chromium steel, he quoted values that had been obtained for two steels of the nickel-chromium type. One was a 3½ per cent. nickel 1 per cent. chromium steel, containing 0·32 carbon. With it a steady rate of creep of 10^{-6}in. per inch per day, which was somewhere about 4×10^{-7}in. per inch per hour, with a stress of 5 tons per square inch at 450 deg. had been obtained. On the other hand, by a suitable adjustment of nickel and chromium contents and an increase of molybdenum content, a steel which had given a stress of 15 tons per square inch and a rate of creep of 10^{-6} at 450 deg. was secured. That was a very considerable improvement without sacrificing anything in the working of the steel. The steels he had quoted gave a stress of less than 1 ton per square inch for 550 deg. Cent. That, of course, was in confirmation of Mr. Baumann's statement that the stresses giving those rates of creep became very low. He felt that the rates of creep given by Mr. Baumann were rather low in that respect.

Continuing, Dr. Inglis said he found it very difficult to appreciate Mr. Baumann's change in the method of design after a temperature of 900 deg. Fah. Below that figure he based his design on the proportional limit with a factor of safety of 2. He himself would like to see the proportional limit cut out entirely so far as high temperatures were concerned. Even at low temperatures it was difficult, and at high temperatures it became almost an impossible physical property. The final point which he wished to raise was with regard to the embrittlement of bolts in steam plants. Being rather interested in that work, he had followed it up recently, and had found that quite a number of steels did become very seriously embrittled when subjected to stress and fluctuations of temperature. A solution of the problem was to adjust the composition of the steel so as to avoid that defect.

Mr Selvey said that there was not the slightest necessity, under modern conditions, for flanges and bolts to assume the temperature of the pipe. He suggested that the proper form of flanges would be something like the dog type clamps which were used in lathes for securing the tool. The design of steam pipes for high temperatures and pressures must be one which gave a very high longitudinal flexibility.

A question had been raised about the oxidation of superheater tubes. Every engineer knew exactly the conditions under which a superheater tube held out. But he did not know when he would get those conditions. Any question of after-burning on a tube which was already heated with gas of 1200 deg. Fah. was exceedingly dangerous. There was no doubt that with the modern type of boiler, particularly when pulverised fuel was used, it was possible to turn on a rush of fuel and get after-burning on the superheated tube.

Mr. Stubbs said that to him it appeared that the creep limit had been invented by investigators who had seen only the shadow, and had been unable to observe the true light. Those investigators had been educated to accept the elastic theory of materials, and in order to be able to apply the known mathematical treatment of that elastic theory, it had been necessary to conceive creep limits. Creep without a limit could not enter into the ordinary scheme of things, and it had been because of the difficulties that creep would introduce in that respect that the scientific investigators had been so keen to establish a limit. Mr. R. W. Bailey had fully realised those difficulties, but at the same time had been unable to agree that actual creep limits had been established, and whilst investigation at that time had not been sufficient to

enable the facts to be definitely stated, Mr. Bailey had asked engineers to suppose that true creep always existed, and he had then proceeded to show by mathematical treatment that certain important results must follow. Mr. Baumann's suggested classification of permissible creep rates was very interesting. As that part of the subject became more fully understood deliberate attempts by engineers to design their plant so as to permit of maximum creep rates would probably be made. For example, the paper gave considerable space to the examination of bolted joints. It was clear that bolted joints were troublesome, and the classification suggested that a welded joint capable of taking the full stress would have ten times the life of the bolted joint, since the suggested rate of creep for the bolted joint was 10^{-6} and for the welded joint 10^{-7}. The paper did not establish a limit for the operating conditions of the steam cycle. It indicated a continued future development, and showed how much easier it was to design for higher conditions than had previously been thought possible. It might be said that creep was a phenomenon which enabled plant to adapt itself to higher operating conditions. By that statement he meant that in the course of time creep would average the stress in a structure, and so enable the structure to deal more effectively with its load. That statement brought engineers face to face with an important conclusion, namely, that the ordinary elastic theory was quite inadequate to their needs when designing high temperature and high-pressure steam plant. It was clear that if full scope was to be given to the development of higher pressure and temperature steam conditions, the designer and the operator of the plant must have exact control of these conditions. The multiple superheater boiler provided for that, and made it possible for the desired steam conditions to be obtained irrespective of slight mistakes in designing and estimating, or irregularities in fuel or other variable factors.

Mr. Russell said the suggested multiple superheater boiler was something new, and consequently would have to receive their very careful consideration, perhaps making them think along different lines. In considering the boiler, it would seem, in the first place, that possible difficulty might be experienced owing to the overheating and final breakdown of the superheater tubes. If it were intended to fire the new boiler with pulverised fuel, the raising of steam was very quick, and, in his opinion, failures might result before sufficient water had been evaporated to circulate steam through the tubes to protect them from the heat of the fire. With the suggested new multiple superheater boiler, there appeared to be little protection of the tubes from the furnace. Then there was the question of the flow of steam through the tubes. It might be necessary in the new boiler to make provision for steam flow control. It was stated on page 31 of the paper that amounts as high as 80 per cent. of the heat of evaporation were transmitted to the furnace walls, and one would imagine that that calculation must be very exact, since it would be difficult to increase the amount of steam from the evaporator drum after the installation of plant, when it might be found that the output of the boiler was lower than required. The boiler did appear to meet a very desirable condition of operation in that it could easily be kept clean by soot blowers, enabling the boiler to be on the range for long periods. Also, it was very accessible, and tube failures could be replaced quickly, whereas in boilers of to-day a tube failure generally meant one tube less until the opportunity occurred to strip a large part of the boiler settings to be able to replace it. Mr. Baumann said that difficulties due to scaling of superheater tubes and consequent overheating were avoided, as the first superheater, which was supplied with steam from the boiler drum, was exposed to low temperature gases only. He would like to ask Mr. Baumann, however, whether trouble of scale deposit in superheater tubes due, apparently, to the overheating of the tubes, had ever come to his notice. In other words, were solids carried over in suspension with the steam likely to be deposited in the superheater tubes if the tubes became subjected to very high temperatures ?

Mr. Favell said that quite recently automatic control had been applied with constant pressure to boiler plant, and that the pressure had been maintained to within one-half per cent. It appeared that maintaining constant superheat had not been adopted as standard practice. The rise in temperature was due to time. In one instance a boiler was under load 300 hours, and the final temperature increased from 680 deg. to 720 deg. Fah., the maximum furnace temperature varying from 2700 deg. to 2800 deg. during that time, with 13 per cent. of CO_2. They usually expected boilers to be on the range about 800 hours, and to do so meant that some means would have to be provided to maintain fairly constant superheat.

Mr. Pennington said there was a feeling amongst station engineers that a stage had been reached in power plant development when further complications were undesirable, and there was a general demand for simplicity. It was doubtful if the proposed new feed system would assist in that direction. In some respects the arrangement rather savoured of first creating difficulties and then proceeding to provide means of overcoming them. It was well known that an extraction pump running at constant speed was inherently self-regulating and operated at all loads without excess pressure on the system, provided the water at the inlet was free to take up its natural level relative to the pump. With the new system, it was proposed to control artificially the level of water in the condenser, thus deliberately causing the pump to develop excess pressure on reduced loads. Speed regulation of the pump was then adopted to remove that excess pressure. The claim that power was saved by regulating the pump speed was perhaps more apparent than real. All the water discharged into the surge tank represented waste power. The full load discharge pressure of the combined extraction lift pump on the new system was approximately 50 per cent. of the boiler pressure. The whole of that pressure was lost through the reducing valve leading into the surge tank. Further, the efficiency of pumping was relatively low. Owing to the fact that a much greater speed reduction was required than would be necessary on the feed pump on a normal feed system for the same pressure reduction, the average motor efficiency was lower. Whether rotor resistance or hydraulic coupling was used, the loss in the drive was approximately proportional to the speed reduction or slip. If his assumptions were correct, it was difficult to appreciate the claim for economy of power; and if speed regulation was to be adopted at all, it was not quite obvious why it should not preferably be applied to the main feed pump in the ordinary way, where the saving in power on reduced loads would be at least real, although of no considerable importance. The proposed system evidently aimed at avoiding operation of the extraction lift pump under so-called "cavitation" conditions. It was an established fact that a correctly designed extraction pump would operate year after year under those conditions, without showing the slightest sign of erosion or pitting, either in the impellers or casing.

In replying to the discussion, Mr. Baumann said it was a fact that manufacturers at the present time had to construct plant, and to give guarantees with regard to its performance at high temperatures without having accurate data of the creep properties of the materials available. He hoped that the information he had supplied in the paper would be followed by similar information from other quarters, and that the steel manufacturers in particular would take an active part in the research work. To substantiate some of the data given, he would like to say that his firm had, at Trafford Park, chromium steel creeping after 5000 hours, and, so far as he knew, it was creeping still at 8000 hours, with a stress of 5 tons per square inch, at a rate of $1{\cdot}65 \times 10^{-9}$. He was not able to compare that figure with that which Dr. Inglis had given, but he had given it to substantiate the creep figures which had been given in the paper. With regard to carbon steel, he was afraid he had no evidence which was as solid as that, but at Trafford Park practically pure iron was creeping after 4000 hours with a stress of 3 tons per square inch, at a creep rate of $4{\cdot}65 \times 10^{-6}$, which was considerably less than that given for carbon steel. He agreed that information on creep was very scarce, and he particularly welcomed the information supplied by Dr. Inglis.

With regard to various other remarks, he said that the boiler described would not meet all the difficulties which were experienced at present in practice. He was afraid that the conditions which Mr. Carey had put forward meant that they were very difficult conditions to meet, and he did not think that the boiler which he had suggested was suitable for that purpose any more than any other ordinary type of boiler. He said that the Loeffler boiler was not a commercial proposition at any pressures below 1800 lb. per square inch.

In a written contribution to the discussion, Dr. G. G. Stoney said that Mr. Baumann's paper was of the utmost value in showing clearly the troubles that might be expected from high temperatures. With higher temperatures, creep became of importance, and there Mr. Baumann's paper was of the utmost value not only by giving the limits of creep allowable in various parts of a steam plant, but also by giving the stresses allowable. He proposed only to deal with the turbine side of the question.

Increasing the temperature by 100 deg. Fah., or, say, from 750 deg. to 850 deg., would decrease the creep strength for turbines to about one-half to two-thirds the value at the lower temperature, and a further increase to 950 deg. would give a further reduction to about half that at 850 deg. Thus, the creep strength at 950 deg. was only one-quarter to one-third of that at 750 deg., and a little higher up for all ordinary materials became practically zero.

On the other hand, the same increase in economy as from 750 deg. to 850 deg. would be given by raising the pressure from, say, 500 lb. per square inch to 575 lb., or for an increase of temperature to 950 deg. the same gain would be got by raising the pressure to 660 lb. It was easy for the practical engineer who had the designing, construction and using of steam turbines, to say which he would prefer, high temperature or high pressure. Increasing the pressure without increasing the temperature caused an increase in the wetness at the exhaust, and there, with blade tip speeds above, say, 800ft. per second, as was universal now, erosion of the last rows of blades might become serious.

Of course, reheating would reduce the wetness, but the cost and complication of that was very great, and besides, the large low-pressure cylinder was exposed to high temperature unless a three-cylinder design was adopted with reheating after the first cylinder.

After all was said and done, it had to be remembered that the cost of producing electricity was only one-quarter to one-sixth of the average selling price, and first cost with ease and certainty of operation were of primary importance.

Obituary.

ERNEST ROMNEY MATTHEWS.

We regret to have to record the death at the early age of fifty-seven of Mr. Ernest Romney Matthews, the Chief Drainage Engineer to H.M. Office of Works and a former Chadwick Professor of Municipal Engineering in the University of London. Mr. Matthews was the third son of the late William Henry Matthews, Chief Officer of the Coastguards in the Hastings Division, and one of the few survivors of the ill-fated troopship "Birkenhead" in 1852. He received his early education at St. Michael's School, Hastings, after which he entered the office of Mr. P. H. Palmer, M. Inst. C.E., then the Borough Engineer of Hastings, and served under him as an assistant from 1890 to 1898. From that year until 1914 he was Borough Engineer to the town of Bridlington, and in addition he acted as consulting engineer to several other local authorities. His principal work was carried out at Bridlington, and included architectural and sea defence works. He further specialised in harbour and foreshore protection works, and the use of reinforced concrete for coast protection, and in that capacity he was an advisor to several municipal and local authorities. In 1914 Mr. Matthews gave a special series of lectures on "Harbours and Coast Defence Works" at Manchester University, and from 1914 to 1921 he was the Chadwick Professor of Municipal Engineering at University College, London. He was also the author of several works on civil engineering problems relating to coast erosion, reinforced concrete construction, refuse disposal and the construction of dams. Mr. Matthews was a member of the Institution of Civil Engineers and a Bessemer and Nursey Prizeman of the Society of Engineers. He was a valued former member of the Institution of Municipal and County Engineers and the Royal Sanitary Institute. During the war he served in France and Belgium as a specialist sanitary officer, and was mentioned in dispatches.

HENRY MARTYN MacKAY.

The death of Mr. Henry Martyn MacKay, Dean of the Faculty of Applied Science, and Professor of Civil Engineering at McGill University, Montreal, is reported as having taken place on October 25th in his 63rd year.

Mr. MacKay was born in Plainfield, Pictou County, N.S., and graduated in Dalhousie College, in 1888. He afterwards entered McGill University, graduating in 1894 with the Bachelor of Science degree, with honours, and the Governor-General's medal for the highest standing in his year. He speedily rose to eminence in his profession, becoming associated with the firm of Waddell and Hedrick, consulting engineers of Kansas City, and was engaged in the designing and erection of bridges and other structures. During that period Mr. MacKay was, for a time, in charge of the work of his firm in Mexico, where he superintended the construction of more than 100 bridges, including some of the largest in that country. He joined the teaching staff of McGill in 1904, and after serving for some years as lecturer, assistant professor, and associate professor was appointed Professor of Civil Engineering in 1908. His appointment as Dean of the Faculty came in 1924, upon the retirement of Dr. E. D. Adams.

Mr. MacKay's loss will be felt not only by his associates, and the student body, with whom he was highly popular, but by the engineering profession over the continent, with which he had been associated as consulting engineer on major projects. Numerous academic honours were accorded him during his career at McGill. Dalhousie University conferred upon him the degree of Doctor of Laws. He was a member of the American Society of Civil Engineers and the Engineering Institute of Canada, a past-president of the Graduates' Society of McGill University, and last year he was appointed a member of the National Research Council of Canada.

BOOKS RECEIVED.

Rechnungswesen im Maschinenbau. By Generaldirektor Herbert Peiser. Berlin: V.D.I.-Verlag G.m.b.H., Dorotheenstrasse, N.W. 7. Price 5 marks.

Quantum Chemistry. By A. Haas, Ph.D. Translated by L. W. Codd, M.A. London: Constable and Co., Ltd., 10–12, Orange-street, W.C. 2. Price 6s. net.

The Indexing of Books and Periodicals. By J. W. T. Walsh, M.A., &c. London: Edward Arnold and Co., 41 and 43, Maddox-street, W. 1. Price 6s. net.

New Mining Electrical Control Gear.

For use in mines, the Metropolitan-Vickers Electrical Company, of Trafford Park, Manchester, has introduced some new and interesting control gear, including a self-contained controller, mining switch units—also supplied as gate end boxes and mining transformer units—and plug distribution boxes. All the apparatus is supplied with flameproof enclosure suitable for use in places in mines where Regulation No. 132 applies, the design for the welded boiler plate cases having been adopted after extensive investigation with special apparatus in the company's research department. A feature of interest

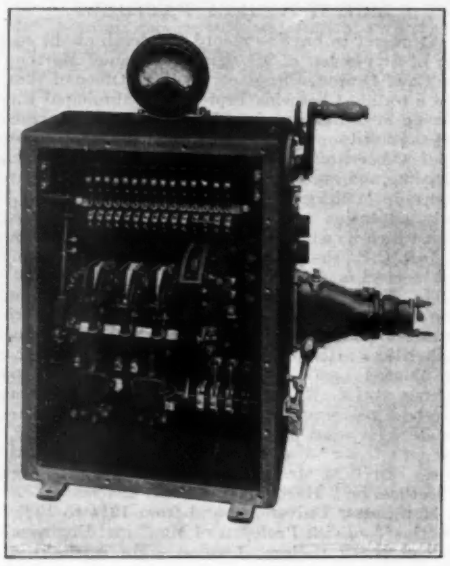


FIG. 1—MINING CONTROLLER

is that, as the apparatus is liable to operate several hundred times a day, in the self-controlled controller and in the mining switch units and gate end boxes, air-break switch-gear is employed. It is well known that when an electric circuit is broken under oil a small quantity of carbon is set free, which in the course of time tends to form paths over the surface of the oil and other insulating materials across which short circuits might occur, and in order to avoid that risk, the oil must be replaced with clean oil at suitable intervals.

In ordinary service circuit breakers which may operate only once or twice a day, periodical inspection may show that it is unnecessary to change the oil more frequently than once a year, but for apparatus liable to operate several hundred times a day, if oil were used, it would require to be changed very much more frequently. In the

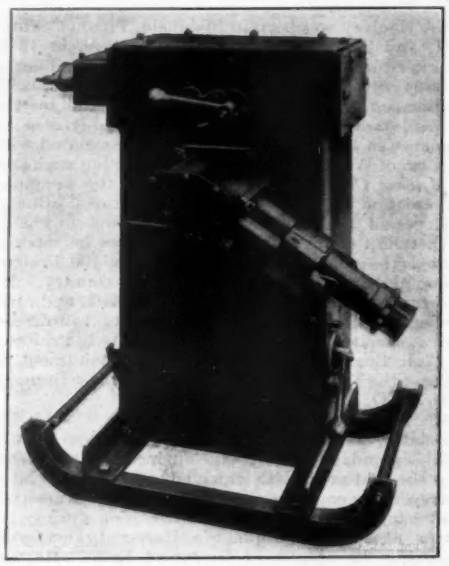


FIG. 2—SINGLE-PANEL SWITCH UNIT

new apparatus considerable trouble and expense are avoided by the use of air break gear, and owing to the absence of oil, it has been found possible to make all the parts more readily accessible and capable of being conveniently inspected and adjusted. The absence of oil and the improved accessibility also result in an appreciable reduction in maintenance charges.

The mining self-contained controllers are designed for the complete control and protection of alternating-current motors up to 60 horse-power and working at pressures up to 650 volts. They are supplied either with an external resistance to control variable-speed slip-ring motors or for use with three-phase squirrel-cage motors, when star-delta starting and reversing are arranged for. They can also be supplied for direct-current service.

A typical self-contained controller in a heavy boiler plate welded case, with wide rough machined flanges, is shown in Fig. 1, but welded cases of water-tight construction are also supplied and are recommended for service underground where flameproof enclosure is not essential. The case contains a six-notch reversing controller, a three-pole contactor switch, two over-current relays, and an externally-operated isolating switch, while on the top of the case there is a flameproof ammeter.

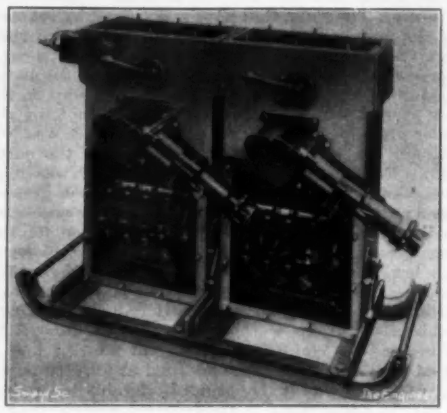


FIG. 3—TWO-PANEL SWITCH UNIT

The controller is of the maker's standard design, but as interlocks ensure that the circuit is always made and broken by the contactor, the service required from the controller is very light, with the result that both the drum contacts and fingers have long lives.

The contactor is fitted with powerful magnetic blow-outs and has renewable contacts which open and close rapidly with a rolling and sliding action. All three phases are broken, so that when the contactor is open the motor is completely isolated. Over-current protection on all three phases is provided by the two over-current relays, one of which is fitted with a double winding. Under-voltage release protection is given by the contactor, which opens when the supply voltage falls below a set value, whilst no-volt no-close protection is given by the contactor, and an electrical interlock which compels the return of the controller to the off position after a shutdown and before the contactor can be reclosed.

The isolating switch is electrically interlocked, so that it cannot be opened until after the circuit has been broken by the contactor. Inside the controller case a cover is fitted over the isolating switch and the live terminals, so that when the cover of the controller case is removed all contacts which are still alive are protected against accidental contact. The external handle of the isolating switch is arranged so that it can be padlocked in the open position.

By the use of this self-contained controller the cost of cable and trifurcating boxes necessary when a separate circuit breaker to control the stator circuit is installed, and the expenses incurred in their installation are saved.

A mining switch unit and gate end box is illustrated in Fig. 2, which shows a single unit, and in Figs. 3 and 4, which show respectively two-unit and four-unit combinations; while Figs. 5 and 8 give views of a typical switch panel and a triple-thermal relay panel. The mining switch units are designed for the complete control and protection of squirrel-cage motors, with capacities up to 40 horse-power for working on circuits at pressures up to 650 volts, and driving portable and semi-portable machinery, such as coal cutters, conveyors, small pumps, &c., at the coal face. The new mining gate end box has been developed to replace the well-known Metrovick gate end box introduced a few years ago for the automatic protection of coal cutters, coal conveyors, and trailing cables. While the service given by the older design has been widely appreciated, the new gate end box is sold at a lower price, and includes various improvements based on the extensive experience gained with the older type. As shown in the illustrations, each unit is contained in a welded case made of heavy boiler plate, and provided with wide machined flanges, so as to be flameproof. The units are supplied either singly or in combinations of 2, 3, or 4 units, comprising switch or transformer units or gate end boxes, as required, either single units or any desired combination being mounted on skids for convenience in movement as the working face is advanced. The engraving—Fig. 5—shows a panel as included in the mining switch unit, fitted with a three-pole contactor, which is provided with an external operating handle and a combined no-volt, no-close and under-voltage release mechanism. In the top left-hand corner there are two enclosed-type re-wirable fuses which protect the under-voltage coil. Immediately below the contactor are three instantaneous trip coils, and below these three thermal overload relays which are also illustrated in Fig. 8.

In the gate end box the switch panel is similar to that shown in Fig. 5, but the hand-operated contactor switch is replaced by a contactor switch having a closing coil which makes the switch suitable for remote electrical control. The contactor is fitted with powerful magnetic blow-outs and incombustible arc shields. It has three poles, so that, with the contactor open, the motor is completely disconnected from the line. The contacts close with a rolling and sliding action and are easily renewed. The external handle—as fitted to the mining switch units—is arranged to be in the up position when the contactor is closed, so that anything falling on the handle would tend to open the contactor. Overload on all three phases is given by the instantaneous trip coils and by the thermal relays. Three trip coils are provided to guard against short circuits, and are set to trip at from seven to ten times the normal full load current, *i.e.*, above the stand-still short circuit current of the motor.

The thermal type relays give the ideal inverse ratio time current protection against normal or small sustained overloads on all three phases. They are adjustable, and can be set to guard against prolonged overloads only just above the normal rated output of the motor. As the action of the relays is based on temperature rise, and not on mere excess of current, they are not actuated by the short current rushes that occur when a squirrel cage motor is switched on the line. The thermal relays are automatically reset on all three phases when the contactor is brought to the off position. Under-voltage release is given by the

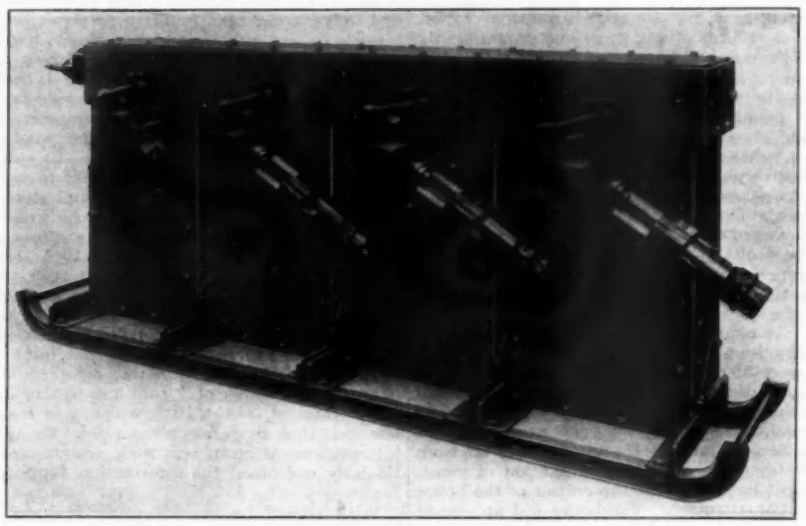


FIG. 4—FOUR-PANEL SWITCH UNIT

contactor which opens when the supply voltage falls below a set value. No-volt, no-close protection is given by a laminated magnet no-volt, no-close device, incorporated in the under-voltage release mechanism. In certain cases both the no-volt, no-close protective features may not be required, and in such cases they can be

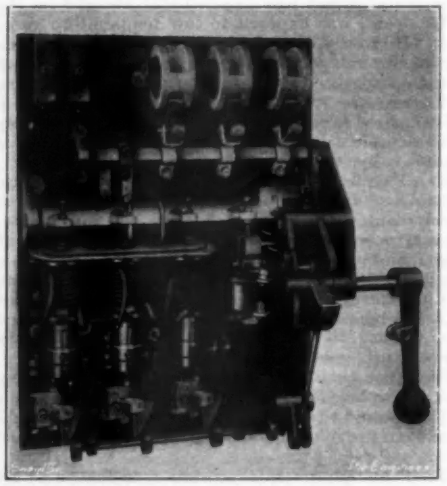


FIG. 5—SWITCH PANEL

omitted, and under-voltage release and overload protection are then only provided. In the top part of each unit there is a separate flameproof chamber, in which bus-bars and an isolating switch can be provided, if required. The isolating switch is operated by an external lever handle, which can be fitted with a padlock to prevent unauthorised use. For incoming cables a trifurcating

DISTRIBUTION BOXES FOR USE IN MINES

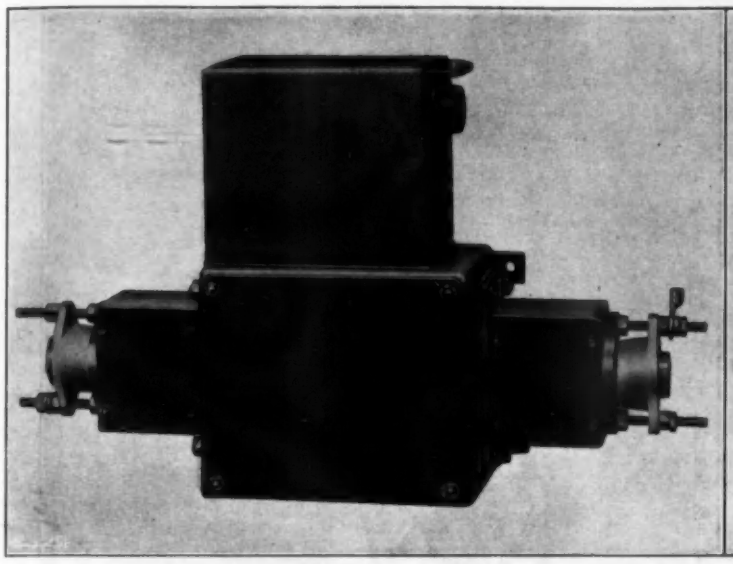


FIG. 6—PLUG DISTRIBUTION BOX

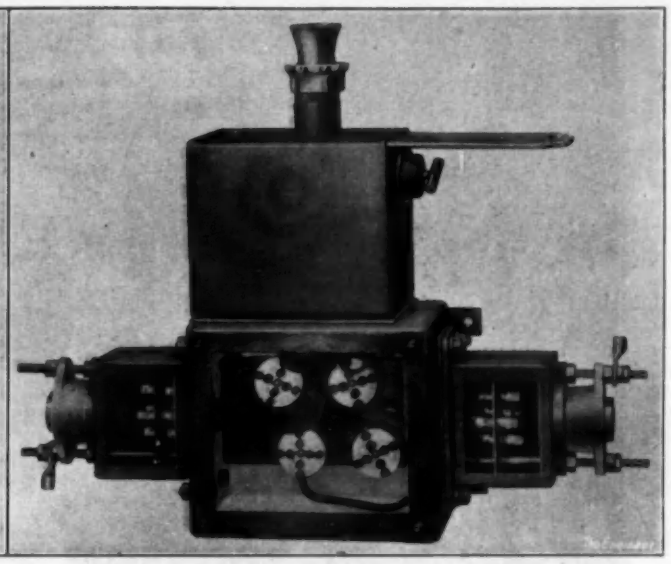


FIG. 7—PLUG DISTRIBUTION BOX WITH COVER REMOVED

box can be fitted to either end of the bus-bar chamber. Provision for the outgoing cable is made just above the removable front cover, and may consist of either a trifurcating box for flexible armoured cable or of a B.E.S.A. four-pin mining type plug and socket for a trailing cable. An ammeter in a flameproof case can be fitted to each unit. Special protective features that can be incorporated include provision for earth continuity protection or earth leakage protection. Where earth continuity protection is required, a small potential transformer is included to give a pilot circuit pressure of 20 volts, as required by the Mines Regulations, and this circuit is taken through a pilot core of the trailing cable, and earthed in the plug and socket at the motor end of the cable. Where earth leakage protection is required, a three-phase core balance transformer and a flameproof leakage trip relay set to operate at 5 per cent. primary leakage are included. In this instance the width of the main case is increased, but it may still be bolted up with other switch units to form a multi-unit combination.

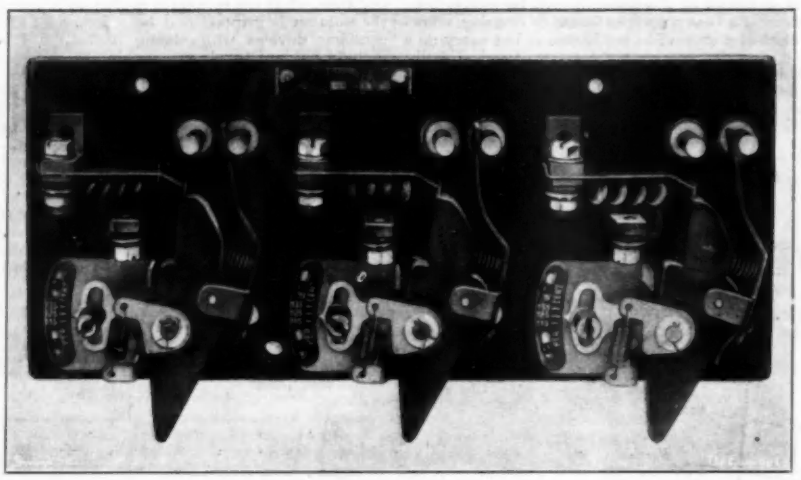


FIG. 8—THERMAL RELAY PANEL

The mining transformer units consist of a standard case having a transformer with fuses for primary and secondary circuits mounted in the main compartment and a bus-bar chamber, with its isolating switch, the latter being used to switch the transformer on or off. The transformers may be single-phase up to 3 kVA capacity or three-phase up to 2 kVA capacity, with the primary winding designed for 440/650 volts, as required, and the secondary for any voltage that may be essential. Mining transformer units can be assembled in combination with switch type units and gate end boxes and are useful to supply lighting circuits at the coal face or to supply power for small motors driving drills, &c.

The mining type plug distribution boxes have been designed mainly for use in connection with electric coal cutters working a long face, and they are inexpensive and portable. When connected to the gate end box in series with each other, and spaced out along the working face, they provide convenient points at which the trailing cable from the coal cutter may be plugged in, as the machine travels along the face. A typical mining plug distribution box with all the covers in position is shown in Fig. 6; whilst Fig. 7 shows the covers removed and a trailing cable plug in position. The distribution box is composed of strong welded steel plate and contains four four-way terminals designed for use with four-core cables. The example illustrated is provided with two branches for a through cable, but provision can easily be made for a third branch. The terminal boxes each contain four terminals, having two pinch screws to receive incoming connections and the inner chamber of each terminal box is sealed with compound before despatch. The plug chamber in each box is fitted with a socket to receive a four-pin, 100-ampère, B.E.S.A. mining type plug, and is provided with a sliding door fitted with a lock. When the sliding door is open, the key cannot be withdrawn, and as only one key is supplied for use at each working face, only one of the distribution boxes can be in use at one time. Of the four sets of terminals provided, three are intended for the three-phase power conductors and the fourth is intended for the pilot circuit. For continuity of the earth circuit reliance is placed on the armouring of the interconnecting cable, armour clamps being fitted on each terminal box, as shown.

It may be added that while mainly designed for the special purpose described, Metrovick plug distribution boxes can also be adapted and are in extensive use for other purposes where a flexible system of plug-in points is found to be desirable.

The Euston Buffer Stop Collision.

THE buffer stop collision in No. 1 platform road at Euston, in which the up "Night Scot" was involved on the morning of September 1st last, was inquired into by Colonel Trench, and that officer's report thereon was issued on November 8th. The train was double-headed, and, as a result of the collision, the buffer planks and main frames of both engines and the tender of the pilot engine were buckled, together with other minor breakages. The leading coach, an all-steel brake van, was undamaged; the second coach, a corridor third, was a good deal damaged at the trailing end, the body being pushed in and the headstock bent. The third coach was considerably damaged at both ends, and the body thrust forward on the underframe into contact with the second coach. The fourth coach was slightly damaged at the leading end. There was no damage to the remaining eleven coaches of the train, except the breakage of three panes of glass and one drop table.

In concluding his report, Colonel Trench observes that, until the similar accident which occurred to a Manchester express on August 27th, 1928, there had been nine minor buffer stop collisions at Euston in five years. Thereafter, owing probably to a more rigid observance of the speed restriction, there had been an interval of two years until the present case.

It is admitted that the 10 miles an hour restriction gives a considerable margin of safety, and, as remarked in the last two reports on similar accidents at Euston, it is of first importance to ensure that this restriction is regularly observed, so that this margin of safety should always be available.

It is the duty of the signalmen in No. 2 box to report any cases in which speed is in excess of this limit, and several such reports have been made in the last two years, suitable action having been taken on such reports when considered necessary.

But apart from the fact that these signalmen are continually occupied with responsible work which requires a high degree of concentration, exact judgment of speed is a difficult matter, and there must necessarily be reluctance to report cases unless it is quite certain that the regulation has been definitely infringed. Colonel Trench imagines that any cases reported in the past have been cases in which the speed has been so much in excess of the restriction that the signalman could have no possible doubt about it, and felt it was his unquestionable duty to report it, as both signalmen state that they would have done on this occasion even if there had been no accident. Nor does Col. Trench see that more can be expected in the future. The extreme solution would be to make a compulsory dead stop outside the station. That would cause delay, and he cannot think it is justifiable to suggest it.

He suggests, however, that the company should investigate whether it is practicable to provide an electrical timing apparatus on the up fast track, which would automatically record the speed of all up trains at a point, perhaps somewhat north of Euston No. 2 box. No great difficulty should be involved, and the psychological effect would be such as to make further cases of excessive speed most unlikely. The practicability of such apparatus is already under consideration by the company.

In spite of the fact that the collision took place at very low speed and would probably have been avoided if there had been a very small additional margin of distance available, the number of persons injured and the damage to stock were considerable. These considerations indicate that the company should investigate fully the possibility of increasing the retarding capacity of the buffer stops on the main line platforms at Euston, although it is realised that it is difficult to stop a train of 700 tons even at very low speed without some shock. On the other hand, any such improvement, by the provision of longer and heavier hydraulic cylinders, or other means, would help to guard against minor accidents of a type more probable than this one, i.e., when a driver has approached with all due caution, but thinking he was going to stop too soon, has released his brake and then misjudged the final application. But he feels no doubt that the enforcement of the speed restriction is the most important factor in avoiding buffer stop collisions at this station.

The results of this accident again draw attention to the value of the special shock-absorbing buffers which were fitted to every vehicle except the third coach.

THE "SOLIDEND" TOOL.—A new form of tool, to which the name of "Solidend" has been applied, has been put on the market by Samuel Osborn and Co., Ltd., Clyde Steel Works, Sheffield. It is claimed to be an important advance on any of the existing types of tipped tools. The tool consists of a solid piece of the firm's S.O.B.V. cutting alloy butt-welded on to a high-tensile steel shank. The welding is done by a complete fusion of metals forming the weld, which it has, it is stated, been proved to be enormously strong, stronger, in fact, than the steel itself. The following advantages of these tools over the ordinary tipped variety are claimed:—(1) The amount of high-speed steel supplied is much greater, which allows for more grinding and gives several times more life; (2) the end is perfectly solid, which admits of heavier cutting; (3) the weld is such that the tool can be rehardened, and, if necessary, reforged without spoiling the weld; (4) the solid end carries the heat away more readily, and, in fact, like an ordinary solid tool; (5) there is no tip to work loose; and (6) in the ordinary tipped tool the mild steel base touches the emery wheel and causes it to become glazed. With "Solidend" tools there is no mild steel to touch the grinding wheel, and the process of grinding is, therefore, perfectly safe.

LARGE DRILLING MACHINE FOR STEEL COLUMNS AND GIRDERS

FIG. 3—HORIZONTAL DRILL CARRIAGE IN POSITION FOR WORK

Large Drilling Machine for Steel Columns and Girders.

WITH the extensive and increasing use in the United States of steel frame construction for large buildings of all kinds—from mills to hotels, theatres and eighty-storey skyscraper offices—there has been naturally a development in machinery to facilitate and expedite the fabrication of structural steel members. Thus, the rolling mills now produce deep joists or I-beams of girder section to replace the shorter lengths of plate girders, and they also produce heavy wide-flanged H sections which are largely used in place of built-up columns or as the cores of such columns, with cover plates, angles, and channels, riveted to the flanges.

For built-up columns and other large members, however, the assembling, clamping and drilling takes considerable time, and requires a fairly large number of men. To expedite this particular part of structural steel fabrication, a machine has been devised—and is now in regular operation—which drills ninety-six holes simultaneously and can handle members of large sectional dimensions. Its special purposes are to reduce the amount of handling during fabrication, to reduce both the time and cost ordinarily involved in assembling and service bolting, to speed up the shop work, and to produce columns so accurately drilled that they require no reaming of rivet holes in either shop or field riveting.

From the drawings and half-tone engravings given herewith and on page 542, the general arrangement and massive construction of the machine will be understood. At the middle is a heavy upright frame or housing, somewhat like that of a steam forging hammer, but carrying a vertically sliding carriage with thirty-two vertical drills. On each side of the housing is a bed-plate with a horizontally sliding carriage with thirty-two drills. At right angles to these bed-plates are the assembling and spacing tables on opposite sides of the housing.

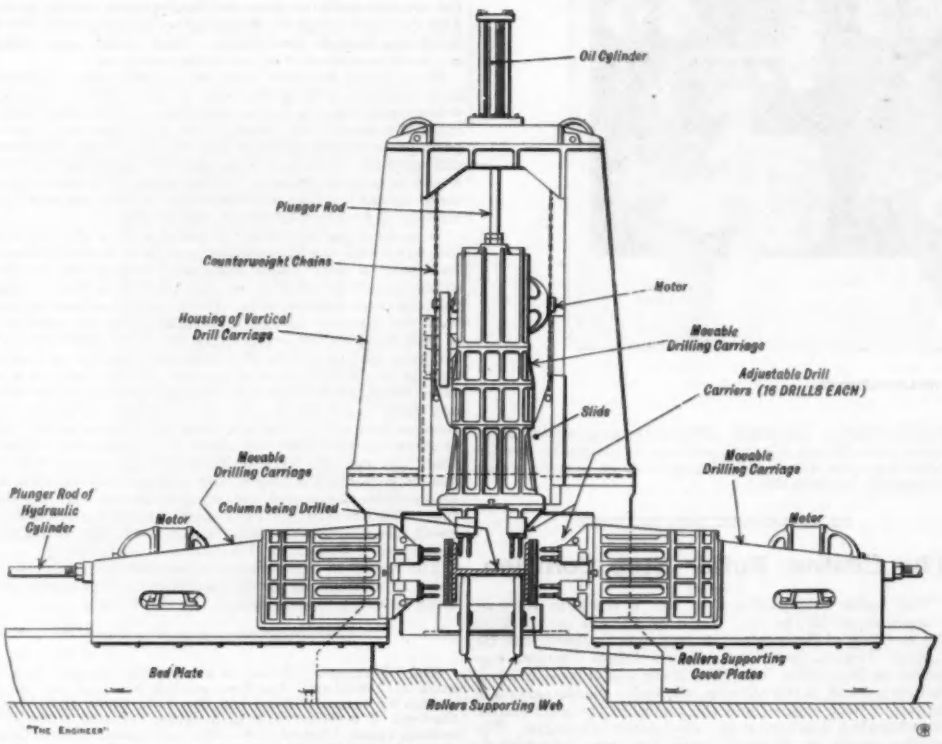


FIG. 4—ARRANGEMENT OF LARGE DRILLING MACHINE

Two views from the assembling table end of the machine are shown in Figs. 1 and 2, with the vertical drill carriage lowered upon the work, but with the side or horizontal drill carriages drawn back clear of the frame or housing. The way in which these horizontal drill carriages are run up to the work is shown in Fig. 1, which also shows the hydraulic cylinder—at the extreme right—for operating the carriage. In Fig. 3—a view taken from the opposite end of the machine—the horizontal drill carriage at the left has been pushed through the frame or housing into position for work. At the right is the spacing table by which the work is pulled through the machine. A general elevation drawing is given in Fig. 4, while the plan—Fig. 5—shows the arrangement of the several parts of the machine.

Material for a column is assembled on a table which has adjustable fittings and clamps to hold the plates and shapes together, while the column is moved up to the drills. Here the column is gripped and held firmly by clamping and centring devices while being drilled. These devices include pairs of toggle arms which are operated by compressed air cylinders and grip the work from above and below. The drilling is done between two sets of these toggles or clamps. The assembling table is 75ft. long, in two sections of 37½ft. each, so that while one column is being riveted another is being assembled. With the ninety-six drills in the three carriages the web and both flanges are drilled simultaneously for a length of about 2ft. Then the carriages are withdrawn automatically, the 45ft. spacing table, in tandem with the assembling table, moves the column forward 2ft., ready for the next round of drilling. The toggle clamps again grip the column and the drill carriages engage the work to drill the next lot of

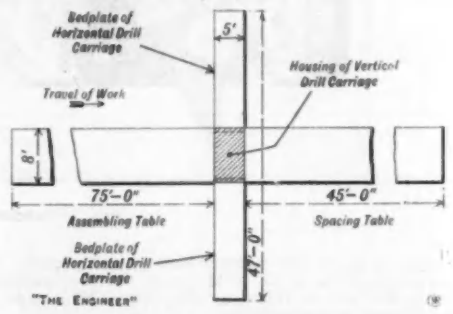


FIG. 5—DIAGRAM SHOWING WORKING PARTS

ninety-six holes. The alternate drilling and moving continue automatically for the entire length of the column or other member.

Each drill carriage has two adjustable heads with two rows of drills, eight in each row, making a total of thirty-two drills. These are all adjustable, so as to suit the number and spacing of rivet holes required. On each carriage is an electric motor which operates the drills and also an oil hydraulic cylinder which gives a pressure of 40,000 lb. Another electric motor operates the three oil pumps for the hydraulic cylinders. All the drills are controlled independently by means of compressed air valves, which, in turn, are controlled from a valve board. Before starting, the operator sets this board according to a blue print diagram of the work in hand, selecting the drills which are required to suit this drawing. Then when the drilling carriages are run into position only the selected drills will be effective, while the others will telescope into the head and do no work. The three carriages may be operated simultaneously or either one separately, as in certain cases there may be rivet holes in only one flange, or in both flanges but not in the web of the member.

Three sets of rollers support the material on the assembling table—as shown by Fig. 6. Disc rollers A A carry the web; horizontal rollers B B carry the cover plates; vertical rollers C C act as guides and hold the parts in alignment, while at the same time maintaining the proper

width. All these sets of rollers are adjustable to suit the dimensions and form of section of the column or girder.

This machine was invented and patented by Wallace W. Smith and Vernon B. Trevellyan, operating under the name of the Structural Service Company, of Chicago. The first one to be built is now in operation at the works of the Inland Steel Company at Chicago. It eliminates service bolting in assemblage, handling at the drills and subsequent reaming of the holes. The member, held together by the clamps, comes from the drilling machine ready for the riveters. With a crew of five men a column 24ft. long, weighing 2½ tons and having cover plates 12½in. wide, has been drilled completely in 25 minutes by twelve operations of the machine, each operation drilling all the holes in a length of 2ft. Columns for a number of tall buildings have been fabricated with the aid of this

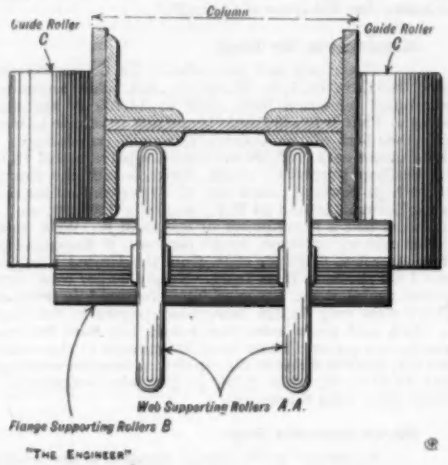


FIG. 6—ARRANGEMENT OF ROLLERS

machine, and the building erection is said to have been expedited to a marked extent by the high degree of accuracy, with consequent elimination of reaming for the field riveting.

A Brake Testing Machine.

On a recent occasion we had an opportunity of inspecting in use a machine for testing the effectiveness of the brakes of motor vehicles in conditions which simulate actual service on the road. It is being supplied by Bendix-Perrot Brakes, Ltd., of Westwood-road, Witton, Birmingham, and the demonstration took place at the Acocks Green depôt of the Corporation Tramways and Omnibus Department, by the kind permission of Mr. A. C. Baker, the general manager. Above we give a photographic illustration of the working part of the machine, while a diagram indicates its principle.

The necessity for testing brakes and adjusting them so that they may each take their proper share of the work has, of course, been recognised for a long time, but the effectiveness of the method employed has generally depended on the nicety of touch of the mechanic making the adjustment. The unreliability of that method is shown by the fact that newly adjusted brakes have been found in which the resistance of opposite wheels has varied in the ratio of 175 to 450. It will be easily understood that with brakes adjusted in that manner their sudden application may result in a skid. If, however, the brakes are adjusted with the assistance of the machine under review it is certain that they, at least, start service with all brakes equally effective. Their subsequent performance, naturally, depends upon the equality of wear of the shoes and drums. Hence, although the manufacture of brake linings has been brought to a very high degree of perfection, it is advisable that vehicles should occasionally be run on to the testing machine to have the brakes overhauled. For this reason some of the larger garages are installing the machine, while it is obviously a desirable item of equipment in large motor car factories, as, apart from the assurance that it gives of proper adjustment, it saves a considerable amount of time.

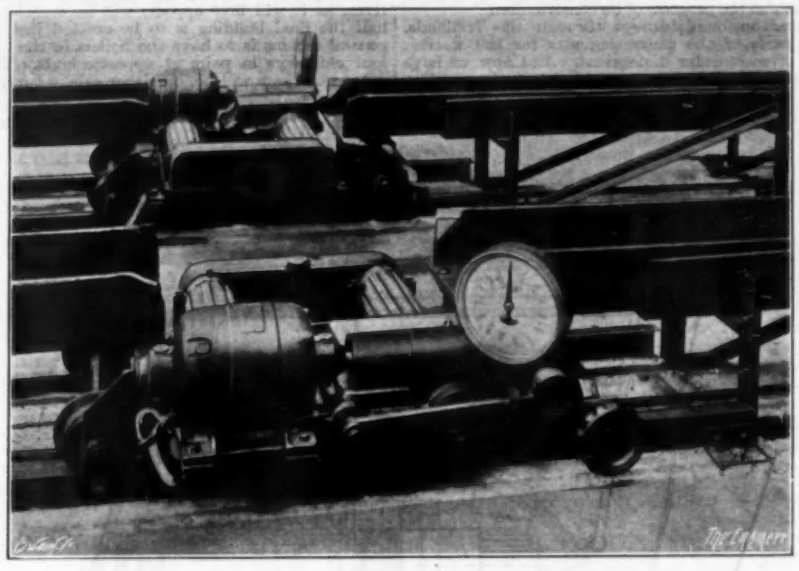
The broad principle of the machine is to drive each wheel of the vehicle by external means with the brakes applied and to measure the torque exerted by the driver. In view of the fact that the braking effect is practically constant for all speeds except zero, it is unnecessary to drive the wheels at any great speed, so that no great amount of power is absorbed, while a careful study of the condition of the brakes throughout one revolution can be made.

The actual machine comprises two ramps, which raise the vehicle to a convenient working height. These ramps are sheet steel troughs, with welded joints, and it is surprising, in view of their lightness, what heavy loads they will carry. They lead up to a platform on which the vehicle is stationed with the back wheels resting between the two pairs of rollers shown in the engraving. In the case of four-wheel brake equipments there may be a second set of rollers for the front wheels, so that all four brakes may be adjusted simultaneously. In such cases it is usual to make the intermediate troughs telescopic, to accommodate different lengths of wheel bases; but the two pairs of brakes may, of course, be adjusted in succession over one set of rollers. In the case of the four-wheel arrangement the machine is mounted on a travelling carriage running on rails on the floor.

The arrangement of the mechanism can best be followed in the diagram, in which the carrying rollers are marked A and B. They are corrugated with the idea of simulating the surface of a concrete road as regards adhesion. The two rolls of each pair under one wheel are geared together

MACHINE FOR TESTING MOTOR VEHICLE BRAKES

BENDIX - PERROT BRAKES, LTD., WITTON, BIRMINGHAM, ENGINEERS



by a chain and one of them is driven, by the electric motor C, through the worm gearing E and the dynamometer F.

The dynamometer is, virtually, equivalent to the back gear of a lathe, with the back shaft mounted in a frame free to rotate about the main axis. The frame is, however, restrained to the extent that a lever attached to it is connected with a spring balance which measures the reaction necessary to transmit the torque through the gearing.

The first wheel of the train of gearing, it will be seen in the diagram, rotates anti-clockwise, so that, on account of the resistance to the rotation of the roller, there is a tendency for the back shaft to climb round the main shaft in an anti-clockwise direction. The second pair of gear wheels, however, has the opposite tendency. That is to say, the back shaft tries to climb round in a clockwise direction. These two "tendencies" or reactions do not balance one another, on account of the gear ratios, and the net result is a torque on the framing carrying the back shaft in a downward direction. This torque is balanced by the spring of the dial D, which is calibrated to read directly.

In practice, the linkage system of the dynamometer is not of the extremely simple form shown in the diagram, although this sketch is true in principle, and a system of levers, similar to that of a weighbridge, is introduced to reduce the magnitude of the force to be measured and thus permit the use of a delicate spring in the dial. The mechanism is, however, comparatively simple, and its execution is, as we assured ourselves by having one of the

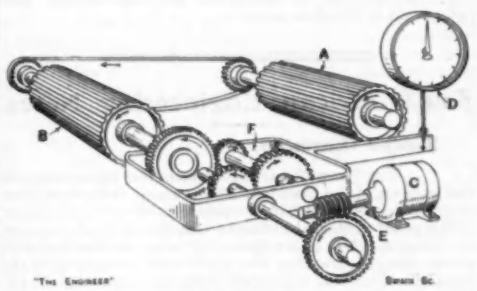


DIAGRAM ILLUSTRATING PRINCIPLE OF MACHINE

gear-boxes opened up, good workmanship. Incidentally, the designer has so contrived the machine that it is comparatively easy to dismantle for examination. Two fitters unfamiliar with the machine completely took it apart quite quickly while we looked on.

It will be realised that the rotation of the rollers under the braked wheels has a tendency to pull the vehicle backwards, despite the slight rise which would be necessary to surmount the back roller. This tendency is, however, met by chaining up the front axle to a fixed anchorage.

In practice, the vehicle is run up the ramp on to the platform, with the wheels between the rollers, and is tied up to the anchorage. The engine is stopped and the gear left in neutral, so that only the back axle and propeller shaft are run by the testing machine motors. For very expeditious work a man then stands in the rear, where he can view the two dials and signals to two mechanics at the two brake adjustments until both are alike; but one man can, of course, do the whole work by taking observations and walking from side to side of the vehicle.

We were surprised at the celerity with which the adjustments were made, although we did not take any actual times, as the occasion was obviously rehearsed; but we were left with the impression that the machine must quickly pay for itself in time saved, apart from the assurance that it gives of the maximum service from the brakes.

Subsequent to the demonstration we paid a brief visit to the makers' works in Witton, where several ingenious processes are employed in the manufacture of brakes for all kinds of vehicles, including aeroplanes.

SIXTY YEARS AGO.

An African explorer, entering a Dutch farmer's cottage, discovered the children playing with a piece of bright crystal. On examination it proved to be a diamond of the first water, worth some thousands of pounds. The news spread and the neighbouring farmers were soon busy searching for other diamonds. A well-known London jeweller sent out an expedition to examine the district, but the report received was unfavourable, and he allowed the subject to drop. Within a few weeks a native unearthed a diamond weighing 83½ carats, which realised £24,000. In our issue of November 18th, 1870, we were compelled to admit that the tales which had been coming in from South Africa were not after all romantic fiction, but that a diamond district of great value existed in the country. The district, we said, was very little known to the civilised world. With the aid of a crude and, as we now can see, an inaccurate map we sought to explain its situation and its topography. Our map showed the area surrounding the junctions of the Orange, Modder, Vaal and Hart rivers. Hopetown was the principal settlement in the district, the other names on the map being principally those of mission stations. The diamondiferous area was, we reported, extensive. It appeared, however, that the most favoured spot was a mission station called Pniel, which, according to our map, lay just south of the junction of the Hart River with the Vaal. The station belonged to the Berlin Missionary Society. That body, we stated, claimed one-quarter of all the finds made in its neighbourhood. Diamonds had also been found further south at the junction of the Modder River with the Vaal. It was estimated that at the date of writing quite 2000 men were busily digging, washing, sifting, and searching for diamonds in South Africa. Interest was being maintained and increased in the undertaking by constant reports of dazzling finds. From Kingwilliamstown it had recently been reported that a diamond of 180 carats, valued at £100,000, had been discovered by Captain Edwards; that Mr. Fourie, after working only fifteen days, had returned with a number of diamonds; that Mr. Hond had obtained 400 diamonds in six days; and that Messrs. Remington and Holmes had unearthed a perfect diamond of the first water weighing 36½ carats. We attempted to give some explanation of the topography of the land and of the circumstances which had led to the formation of the diamond deposits. The explanation is difficult to follow, but it is evident that behind it there was some idea of alluvial pipes in accordance with facts which were subsequently discovered. With properly directed enterprise and skill, so we wrote, the district of South Africa with which we were dealing would undoubtedly become one of the richest and most valuable areas in the world. The future of the Colony could not as yet be foretold, but it was certain that an important era in the history of South Africa was approaching. Our remarks were justified. The mission station of Pniel was very close to, if not coincident, with the site of the Kimberley fields.

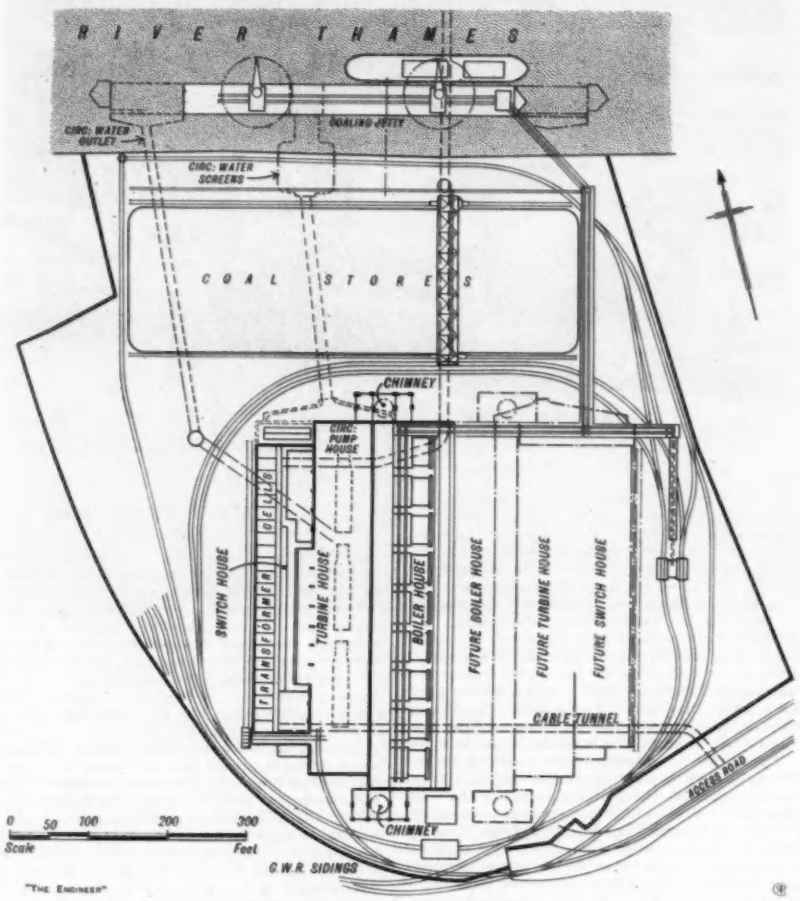
The Institution of Electrical Engineers.—At the Ordinary Meeting of the Institution of Electrical Engineers, to be held at 6 p.m. on Thursday, November 20th, 1930, an oil painting of Ampère will be presented to the Institution on behalf of Mr. E. Garcke. The portrait is by Mr. Edgard Maxence, Membre de l'Institut de France.

Development of the Aluminium Industry.—A competition open to inventors of any nationality will be held by the International Aluminium Bureau with the object of encouraging the development of the aluminium industry. Prizes will be offered for the best suggestions for new applications of the metal and its alloys or for improvements in its manipulation. Subject to certain provisions, the competition will be held annually. It will be divided into two sections:—Section A: Direct applications: This section will deal with all proposals relating to the manufacture of an article or machine or part of a machine in aluminium or aluminium alloy. Section B: Indirect applications: This section will deal with all proposals relating to improvements in the methods of working or using aluminium or its alloys, *e.g.*, soldering, insulating, plating, &c. Particulars can be obtained from the British Aluminium Company, Ltd., King William-street, E.C. 4.

The Battersea Power Station.

THE Battersea power station of the London Power Company has been so much in the limelight during the past eighteen months that we willingly accepted an invitation to examine the progress of its construction.

We have, on our journeys through the Midlands, observed parts of the generating sets for the station. They are of spectacular dimensions. And now we have been impressed with the extent of the coming station itself. Ultimately it will cover an area of 15 acres, as shown on the accompanying plan. At the present, however, only half of the buildings are to be erected, while the generating plant is to be, for the time being, one-third of the final designed capacity of 400,000 kilowatts.



SITE PLAN OF BATTERSEA POWER STATION

As things stand at present the half-site has been almost completely prepared up to datum level, which approximates to the floor of the condenser basement. For this purpose it has been necessary to sheet-pile some extensive areas and to excavate the shingle down to the level of the London clay. We noticed, incidentally, that the contractors were quite catholic in their choice of steel piling. But that may be accounted for by the fact that some of the excavations have gone down to a depth of 75ft., while others are comparatively shallow. Anyhow, all the big holes have been successfully made, concreted round, and the sheet piling is now in progress of extraction. In other words, the excavating engineers are now giving place to the constructional engineers.

The former, in their work, have, however, had to combat several difficulties, as the site is supposed to be that of the natural drainage route from the Clapham heights, and some most elusive beds of gravel and clay have been met, while several unrecorded culverts have been discovered. We noticed the exposed end of one of these culverts. It is some 10ft. in diameter, and although it is at least 25ft. below the present ground level, its brick arch is only two rings thick. It must have been put together well. Again, in driving the sheet piling, some most unexpected obstacles were met, but, on the whole, little water has found its way in and pumping has not been a serious item. Even in driving the tunnel under the Thames, for the accommodation of the electric cables, only that section directly under the river was bored under compressed air. And then the expedient was adopted rather as a precautionary measure than a necessity. We were impressed with the roominess of this tunnel, which is of the orthodox cast iron lined type. There is another cable tunnel leading southwards to the main road, but it was made on the cut-and-cover principle. Several other tunnels have had to be made for the service of the station, principally for condenser-cooling water, but they are really concrete culverts, or cast iron pipes laid in the open, but now covered with the main foundations.

At the time of our visit one bay of the boiler-house was approaching completion, and some idea of its dimensions may be gained from the fact that the top drums of these boilers will be over 50ft. above the firing level. The framing for carrying them—there will be nine of them for each half of the plant—has a decidedly massive appearance, and requires the attendance of some really large cranes for its assembly. So far little has been done towards the erection of the turbine, switch and transformer room framing, but it should not take long to put in place, with the foundations finished and the extensive equipment on the site. The chimneys, with their fume-washing appurtenances, which we described in our issue of October 10th, have not yet been put in hand, but their foundations are ready. Their total height, we are now informed, will be about 360ft.

It may be as well to point out that the frontage on the river, as it will first appear, will be one-sided, as only half the final building is to be erected just now. The general scheme is to have the boilers in the centre, with four chimneys in pairs at opposite ends. Then, going outwards, there will be, on either side, a turbine room, a switch room and a transformer house of steadily decreasing elevation. The appearance of the completed building will, undoubtedly, be handsome, although it may look rather odd in its initial stage.

South African Engineering Notes.

Radcliffe Observatory.

THE Town Council of Pretoria has agreed to grant the trustees of the Radcliffe Observatory, Oxford, a piece of ground in freehold, approximately 50 acres in extent, in the event of their deciding to transfer their observatory to Pretoria. Dr. Knox-Shaw, Director of the Radcliffe Observatory, in making the application on behalf of the Radcliffe Trustees, explained that, as the result of Dr. Steavenson's observations on Klapper Kop, the trustees were unanimous in their decision to transfer the observatory to South Africa, but in view of the fact that the Trust had been founded some 200 years ago, it was necessary that permission be obtained from the Court of Chancery for the proposed change. It is understood that it is intended to purchase a telescope with a reflector of probably 72in. in diameter.

Electricity Supply Commission.

The Electricity Supply Commission has issued its seventh annual report covering the year ending December 31st, 1929, together with a brief review of its activities up to April 30th of this year. The year 1929 was the first complete year throughout which all the Commission's five undertakings were in operation. The Commission's energies are now directed principally to the production, distribution and supply of electricity, but a good deal of construction work is in progress in connection with extensions to the undertakings, both in respect of power station plant and on the distribution system. Within six years of the appointment of the Commission, five schemes were in operation, with an output aggregating approximately 800 million units per annum, that fact demonstrating the extent to which there is scope in South Africa for the operations of such a body as the Commission. In the more outlying towns and districts adjoining the areas now served, schemes of supply are, in many cases, financially impracticable for the present, owing to the relatively small loads available and the length of transmission involved. Development in the near future is, therefore, largely dependent upon the increases in the requirements of existing consumers and the establishment of any new industrial enterprises in the areas concerned. The figures of primary interest in connection with the five undertakings—Natal Central, Witbank, Cape Town, Durban and Sabie—during the year 1929 are: Capital expenditure at December 31st, 1929, allowing for £150,313 net revenue during construction, £7,655,040; total revenue, £985,152; total production costs, including interest and all other capital charges, £990,270; excess of production costs over revenue, £5118; total capacity of main generating sets, kilowatts, 207,350; total electricity sales, units, 796,998,351; average cost per unit sold, 0·298d.; total coal consumption, tons, 693,325; number of consumers, 1017; total area of supply, 11,000 square miles. The Commission is, of course, required by Statute to operate its undertakings, as far as practicable, neither at a profit nor at a loss. The electricity sales represent an increase of 169,086,056 units, or, approximately, 27 per cent., as compared with the year 1928. Up to the end of last year the capital advanced by the Treasury, including raising charges and interest capitalised, amounted to £8,000,000. The account disclosed an excess of assets over liabilities of £480,422.

Motor Cars in the Union.

Motor cars and taxi-cabs in the Union increased from 38,815 in 1923 to 130,360 in 1929, while lorries and omnibuses increased from 1989 to 14,769 in the same period. That is to say, there is one motor vehicle to every nine members of the Union's European population. Of these motor cars, 112,194 are used for private and 18,166 for business purposes. South Africa is still the country of the high-powered motor car, 52·83 per cent. of the total being between 20 and 24 H.P., and only 3·68 per cent. of the total had a horse-power of less than 9. With regard to the country of origin, 89·68 per cent. of the cars came from America, 6·85 per cent. from the United Kingdom, and 1·95 per cent. from Italy. Nearly 80 per cent. of the motor cycles were, however, manufactured in England. There were only 72,239 income-tax payers in the Union in 1929, and there were thus nearly two cars for every income-tax payer. There were 706 garages in the country in 1929, and the value of the repair and erection work done was £3,317,419, while 6508 people were employed, of whom 4591 were Europeans.

Marine Engineers Busy.

A number of the vessels engaged in the whaling industry in the Southern Seas are making Cape Town and Durban their South African headquarters for refitting and repairing. Such a considerable volume of business has been brought to the local marine engineering works that at Cape Town it has been necessary to construct another small floating dock to give additional facilities. The principal South African companies interested in this class of vessel are Irom and Johnson (S.A.), Ltd., and Thesen and Co., Ltd., who, with their subsidiary companies, own fifty-six whale catchers and trawlers. Foreign companies, mostly Norwegian, are now sending about forty whaling vessels to Durban and Cape Town to be refitted each season. The value of the industry to Cape Town during the past twelve months is said to have been approximately £70,000, while between 500 and 600 men are employed during the busiest periods in overhauling, repairing, and painting the vessels. The cost of ordinary repairs and dock charges for each vessel is roughly £2000 for each off season, while damage by ice and other special repairs will naturally increase the amount very considerably. The year 1929–30 whaling season's return to the companies was, however, a world's record, the value of the oil produced in southern waters being estimated at approximately £7,000,000.

Turning Railways into Tramways.

The serious losses which are being sustained on the Cape Peninsula suburban lines are likely to result in revolutionary changes. A short time back the Minister of Railways threatened that, if the passenger traffic did not improve, the lines would be scrapped, but no doubt he has realised that that step would have met with fierce opposition. Now the railway authorities are seriously considering a proposal to run the Cape Town–Simonstown line on the tramway system—that is to say, to have stops and to leave the issue of tickets to a conductor on the train. A special study of the whole problem has been made by an officer of the Administration, and the report, which is due for presentation shortly, is expected to have important results.

Mineral Output.

The total value of the mineral output of the Union for the first half of 1930 was £24,995,434, compared with £24,957,530 for the corresponding period of 1929. The value of the gold produced was £22,383,003, compared with £22,058,480. This increase was, however, counterbalanced by the falls in copper and tin, asbestos, coal, &c. The quantity of coal exported decreased by 204,000 tons and the value by £68,000. The June export of minerals showed that, for the first time, substantial shipments of Portmasburg manganese were made. Up to the end of July about 24,000 tons, worth nearly £50,000, had been shipped. The value of the diamonds produced for the first six months of the year 1930 is not known, but is well under that for the corresponding period of last year, as the price per carat has fallen and the quantity produced also.

Industrial Census.

The preliminary report of the fourteenth industrial census just issued by the Department of Census and Statistics, contains figures which show that the number of Europeans and natives employed in industry has more than doubled in the last fifteen years. During 1928–29 there were 7461 industrial establishments in the Union with a total capital of £65,541,000, employing 89,236 Europeans and 217,660 persons of all races. The wages paid out to Europeans was £19,630,000 and to all races £26,546,000. The gross value of output of these establishments was £113,441,000, while value added to materials was £54,520,000. All these figures represent increases on those for the previous year, and show that the number of industrial establishments has increased from 3998 in 1915 to 7461. In 1915–16 there were 39,524 Europeans employed in industries, and 101,178 persons of all races. The total capital invested was £27,552,000. The gross value of output was £40,435,000 and the value added to materials £18,119,000.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

No Improvement.

SETTLED depression has marked the week in the Midlands and Staffordshire. In the iron and steel trades, and most of the engineering industries, business has been decidedly quiet, while at the local foundries there has been a considerable amount of inactivity, and further hands have had to be discharged or suspended. Current consumptive requirements in all departments are very much below productive capacity, and even much below current output. Stocks are increasing all round. At date there are no indications whatever of any expansion in the demand, either for iron or steel. There was a reasonably good attendance on 'Change in Birmingham this week, but the business transacted was extremely small. The pressure of continental supplies shows no abatement, and industrialists consider that the existing state of affairs is likely to continue for some time yet. It is now certain that the diversion of trade to foreign mills, no matter what its volume may have been, is having a serious effect upon local producers' position. November, instead of being, as it is normally, a good trading month, gives the impression of being in all likelihood as lean and unsatisfactory as recent months. Industrialists here are keenly scanning the horizon for even the slightest evidence of a break in the present trade depression.

Raw Iron.

There have been no developments in the raw iron department in this district during the past week, and the unsettled and unpleasant feeling over selling prices which has marked the market of late continues unabated. Consumers are buying from hand to mouth, and only when absolutely compelled, while where contracts have been entered into specifications are for small quantites at irregular intervals. Derbyshire blast-furnacemen appear to be disposing of their current output, and stocks are not large. At some of the Northamptonshire furnaces, however, already heavy stocks are reported to be growing in size. Luxembourg pig iron is still being offered at £3 7s. 6d. delivered in the Black Country, but it does not appear to be receiving very widespread attention, though a number of foundrymen are said to be using it in place of Northamptonshire No. 3 foundry, which costs £3 10s. delivered. Smelters continue to argue that lower selling rates would mean an uneconomic level, but consumers of pig iron are emphatic in their assertion that there is no justification for the present high level of prices. Foundrymen and forgemen in this area are moderately and poorly employed respectively, and their modest requirements are easily met by Midland furnaces.

Steel.

In the finished steel trade in the Midlands and Staffordshire mills are in need of new business and of larger specifications on contracts. Structural firms hereabouts have had more inquiries during the past week or so, but orders are scarce, and there is keen competition which keeps prices on a low level as far as profit-making is concerned. The basis prices of heavy steel remain at £8 7s. 6d. for angles, £8 10s. for joists, and £8 17s. 6d. for ship, bridge, and tank plates of ¼in. and over. Mills are reported to be rolling small orders, such as 10 tons, having to change the rolls even for so small an output. Quotations for imported steel are not materially different from those which prevailed a week ago. Foreign sheet bars can now be bought at £4 6s. to £4 7s., compared with £5 15s. for the product of mills at home. Billets are on about the same footing as sheet bars. Belgian No. 3 iron bars have been heard of as low as £5 delivered, and steel bars at £5 2s. 6d. A fair quantity of foreign material is being used in this area, and though continental merchants are dissatisfied with the volume they are of opinion that they are getting a fair share of the orders given out, alike for semi-finished and finished steel. The market for steel scrap remains exceptionally quiet. Prices are low, and holders are now waiting for an upward turn in metal values. Demand for scrap is controlled by activity at the steel works, hence the present poorness of business.

Manufactured Iron.

In South Staffordshire there is no change of any note in the finished iron trade. Business is very difficult to secure. The marked bar mills are carrying on, but they hold only very small reserves in the way of orders. The rest of the trade find it increasingly troublesome to keep the mills open. Makers of iron strip are working about four days a week, but are only maintaining operations with great difficulty. Producers of Crown bars and nut and bolt and fencing iron report trade to be stagnant, and in these branches any prospect of trade improvement this year is dismissed as something too much to hope for. Ironmasters see no reason for interfering with present selling values. A lower range of values, even if it were economically possible, would be unlikely to bring about any marked advance in demand. Marked bars are £12 10s., Crown bars £10 to £10 7s. 6d., nut and bolt and fencing bars £9 upwards, and wrought iron gas tube strip £10 17s. 6d.

Sheets.

There is no improvement to report in the galvanised sheet trade. The orders coming through from overseas are generally for relatively small lots, and the support afforded the industry by the home trade is insufficient in volume to keep the mills running regularly. Selling prices are maintained on the basis of £11 12s. 6d. per ton for 24 gauge corrugateds. The call for black sheets for motor engineering purposes expands slowly, but it is still below the normal level for the time of the year. Values in this department have undergone no change.

Coal Marketing.

Colonel W. E. Harrison, D.L., Chairman of the Cannock Chase Coalowners' Association, has been elected Chairman of the newly constituted Cannock Chase Coal Marketing Board. The Deputy Chairman is Mr. B. Madew, of the West Cannock Colliery Company, Ltd., Hednesford, and the Secretary Major J. Selby Gardner. The executive board consists of sixteen owners or their representatives, each from different concerns, and they will be elected annually. Stern penalties are to be imposed on any coalowner who exceeds his output quota or who sells at a price lower than the minimum fixed by the regulations.

Effect of Coal Mines Act.

Mr. A. J. James, general manager of the Littleton Colliery, Cannock Chase, at a recent meeting stated that under the Coal Mines Act the Littleton Colliery, which is one of the largest and most up-to-date on Cannock Chase, and which has been working almost full time for the past two years, will work only three days a week.

Black Country Miners' Wages.

When the South Staffordshire and East Worcestershire Joint District Board for the Mining Industry met at Dudley, the owners made the following offer to the men's representatives. That provided the men agree to the spread-over of 90 hours per fortnight, as provided by the Coal Mines Act, 1930, they shall get six days' pay for a 45-hours' week at the present rate of wages, with a corresponding percentage advance to contract men. If short time is worked, the men will be paid on an hourly basis. The employers intimated that if a rigid 7½-hour day was insisted upon, they would be compelled to press for a reduction in wages. It is understood that the men's representatives have taken the proposal back to their districts.

Unemployment.

The number of workless in the Midlands continues to grow, and there are now 190,411 persons wholly unemployed, 105,954 temporary stopped, and 451 normally in casual employment, making a total of 296,816. This is 2579 more than a week ago and 139,555 more than a year ago. The total comprises 205,658 men, 6312 boys, 79,219 women, and 5627 girls. The figures for the various towns are :—Birmingham area, 52,177 ; Stoke-on-Trent area, 26,638 ; Coventry, 10,210 ; Cradley Heath, 7834 ; Derby, 8316 ; Dudley, 5683 ; Leamington and Warwick, 1151 ; Leicester, 11,931 ; Northampton, 5508 ; Nottingham, 12,849 ; Oldbury, 2125 ; Peterborough, 928 ; Redditch, 1692 ; Smethwick, 5390 ; Stourbridge, and Brierley Hill, 5021 ; Tipton, 3092 ; Walsall, 8202 ; Wednesbury, 3790 ; West Bromwich, 4268 ; Wolverhampton, 11,782 ; Worcester, 2146 ; Bilston, 4656.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Another Victim of Reorganisation.

ON more than one occasion during the past twelve months reorganisation and rationalisation have claimed victims among engineering establishments in Lancashire. The latest and one of the most important promises to be the Preston works of the General Electric Company, Ltd., known throughout this part of the country as "Dick, Kerr's." An official deputation, representing Preston Corporation, has interviewed the G.E.C. directorate in London, but beyond the fact that the situation has been made clear, the journey has been fruitless. Apart from the general electrical engineering side of the business, the works have been prominent during the past thirty years—they were established in 1899—in equipping tramcar systems throughout the world. Normally, the working staff numbered about 3000 people, and during the war years 5000, but lately it has been no more than about 1000, many of them girls employed on winding operations. The G.E.C. directors have decided to complete the engineering work already in hand, but, according to an official statement, there will be a gradual transference of the work of the engineering side to the branches at Stafford, Rugby, and Bradford. The decision does not, however, apply to the tramcar-building works at Preston, and an extension of that department is aimed at.

More Short Time at Locomotive Works.

Further rigid economies are being enforced at the Crewe locomotive works of the London, Midland and Scottish Railway. About 700 men employed in one of the large erecting shops have been suspended for this week, and a large number of apprentices who have concluded their period of apprenticeship have been discharged. The latter step is in accordance with the policy which the company has adopted comparatively recently.

Work on Liverpool's New Bridges.

A contract which will involve some 1600 tons of British steel has been placed with Dorman, Long and Co., Ltd., of Middlesbrough, by the Mersey Docks and Harbour Board. The contract relates to the construction of three rolling bascule bridges at Liverpool at a price of £96,969, the work to be completed in nine months. Both road and rail traffic are provided for in the case of two of the bridges, whilst the third is intended only for road traffic.

Coal-handling Plant for Swansea.

The Hydraulic Engineering Company, Ltd., Chester, has secured a contract for the supply of a 30-ton coal hoist and traverser for the Queen Alexandra Dock, Swansea, four of this type having already been provided by the company for the same dock.

Non-ferrous Metals.

Mixed conditions with regard to prices have obtained on the non-ferrous metals market during the past week. Copper has experienced fluctuations, largely due to speculative influences, but on balance standard brands have finished up about £1 a ton higher on the week, thus consolidating the recent improvement and bringing quotations above what they have been since about the end of September. The lower prices lately ruling brought out a bigger volume of buying than for some time, but more recently this has eased off appreciably, and at the moment demand is quiet. Future movements in this section will probably depend to no small extent upon the measure of success which attends the output restriction negotiations now in progress. In the case of tin, there has been little improvement either in the statistical position or in the demand for industrial purposes, and here, also, values have had their ups and downs, with, however, a net advance of a few shillings compared with a week ago. Offers of lead are being freely made, and supplies are certainly more than sufficient to meet the current demand. Prices have lost ground to the extent of about 5s. a ton, but at £17, which is the value of English metal at the time of writing, quotations are still above the level of a fortnight ago. A poor trade inquiry for spelter, coupled with growing stocks, has been sharply reflected in the market position of the metal, and more than half of the previous week's advance has been wiped out.

Iron and Steel.

Lancashire constructional and locomotive engineers recently have secured new orders, but in neither case have they been more than sufficient to offset the work that has reached the completion stage, and the general position from the point of view of steel business is therefore as quiet as before. Both steel rollers and pig iron makers hold out little hope of business on the Lancashire markets undergoing any appreciable improvement before the turn of the year, and in all directions current buying is largely a matter of early delivery transactions. Only here and there, however, have prices given way. Foundry iron continues to be offered for delivery equal to Manchester at 72s. per ton, with forge iron at 5s. less. Scotch iron is slow and easy at about 91s. per ton, and West Coast hematite at 84s. 6d., both delivered in the Manchester area. Bar iron keeps up at £10 5s. per ton for Lancashire Crown qual.ty, and £8 15s. for No. 2 material. Boiler plates are easy at about £9 7s. 6d. per ton and small re-rolled bars at from £7 7s. 6d. to £7 10s., but the controlled materials are maintained at £8 10s. for joists, £8 7s. 6d. for sections, £8 17s. 6d. for general plates, and £9 7s. 6d. for large-diameter bars. Local users of foreign steels are poorly employed for the most part, and this is reflected in the demand in this section, the extraordinarily low prices being asked for continental iron and steel products having had little, if any, apparent effect on consumption. For delivery in the Manchester area, imported billets and sheet bars are now obtainable at below £4 a ton, with steel bars at £4 17s. 6d. to £5, wire rods at £5 18s. 6d., joists at about £4 15s., angles at £4 17s. 6d., steel bars at £4 17s. 6d. to £5, Siemens plates at £6 5s., and Belgian bar iron at £5.

BARROW-IN-FURNESS.

Hematite.

There are at last some signs of an improvement in the hematite pig iron trade, and they are welcome. The increased number of inquiries received during the past month or so showed that requirements were likely to increase, but buyers were none too eager to commit themselves. It looks now as if customers were experiencing better business which necessitates heavier deliveries than have obtained for some time. The increase in business is not heavy, but it is well defined, and there are signs that the better demand will continue. There have been shipments to the Continent and Philadelphia during last week, the cargo of pig iron for America going direct. This iron will have been supplied by several makers in the district. The demand for better qualities is slightly better, and ferro-manganese is again being produced after a period of idleness at the works in Cumberland. The iron ore trade is not much changed, but it will feel the better state of the iron trade immediately, not only as far as local demand is concerned, but as regards outside users of local hematite ore. The steel trade still remains very dull. If only the rail departments could be got going again the position with respect to iron would improve vastly. Shipbuilders could do with more orders, and the engineering departments in this district are not as well employed as they were.

SHEFFIELD.

(From our own Correspondent.)

More Cheerful Tone.

THERE is an impression in Sheffield that, after the long period of depression through which trade has passed this year, the outlook has at last become more favourable. The month of August was, in many departments, one of the worst known for a long time, and September was not much better, but during the last few weeks there has been a movement in the right direction, although it is yet but slight. It relates more to the lighter and finished branches of the steel trade than to the heavy side, and to the home trade rather than to exports. The increased business is not very evenly distributed, and only a limited number of firms are feeling the benefit of it at present.

The Heavy Steel Trade.

The extent to which the depression continued during September, so far as open-hearth steel production is concerned, is shown by the official figures of output which have just been issued. August, a broken month and a bad one at that, had an output of steel ingots and castings, in the Sheffield area, of 72,900 tons. September could only go a very little better, the figure being 75,700

tons. The tremendous drop is seen when this is compared with the 122,000 tons of September last year. Lincolnshire, however, made some progress in September, when its production was 65,700 tons, as against only 37,400 tons in August, and 64,500 tons in September last year. The pig iron produced in Lincolnshire during September was 56,400 tons, which was equal to the August output, but showed a fall of 9000 tons when compared with September, 1929. The improvement that has been noticed does not relate to these branches. In Sheffield, none of the idle furnaces have been put into commission. There is an absence of bulk orders, and such work as does come in is so intermittent that it is difficult to see employment ahead for more than a week or two even for the limited plants that are in operation. The pig iron position in Lincolnshire may be judged from the fact that only two blast-furnaces out of four are operating at Lysaghts', two out of six at the Appleby works, and three out of four at the Frodingham works. More than half the steel-melting furnaces in that district are also standing idle.

The Fall in Exports.

While seasonal influences have produced increased business in the home market, there is no improvement to report in trade overseas. Practically every country with which Sheffield deals is taking less goods, and in some cases the decline is very marked. It is the collapse of trade in this department which is the chief cause of the present depression, and people are asking how long it will be before different countries find it necessary to resume buying on something like a normal scale. The outstanding case is that of Australia, whose purchases have been so cut down that it is thought that stocks must have reached exhaustion point. Saws, files, edge tools, engineers' small tools, and other essentials, cannot be made in the Commonwealth, and are not being obtained from any other source. An analogous state of things exists, though perhaps to a lesser degree, in some other countries. It is obvious that buying must be resumed sooner or later, and the question is, how soon? When the process of replenishing stocks does begin a good rush of orders may be anticipated.

Railway Work.

The departments producing axles, tires and springs for the railway service are only poorly employed. While the home railway companies continue to give out what orders they can, in a fairly steady flow, the volume is considerably below normal, in consequence of decreased traffics and enforced economies, and there is not much work on hand for overseas. Tenders are now being invited for supplies to India. The Bombay, Baroda and Central India Railway Company is in the market for steel tires for locomotives, copper fire-box plates, steel pipes, boiler and flue tubes, and material for building 15 "Y D" class locomotives. The India Store Department is asking for quotations for 23 locomotives with tenders. It is not very encouraging, however, to read that the latter authority has recently placed contracts for 16 locomotives with German firms.

Special Branches.

There is still a good volume of work on hand in the production of alloy steel and parts for the automobile builders, and this branch, though below the normal, is one of the most satisfactory in the city at present. Stainless and corrosion-resisting steels are also in demand, and their use is still spreading. New applications of these materials have brought an increased trade to the re-rolling mills, which prepare the sheets and bars to various specifications. The cold-rolled steel branch is finding work difficult to obtain owing to the growth of competition, both at home and abroad. Progress continues to be made in alloy steels and cutting tools. One of the latest developments here is an improved type of tipped tool which has just been placed on the market by Samuel Osborn and Co., Ltd. It contains a solid piece of the firm's S.O.B.V. cutting alloy, butt-welded on to a high tensile steel shank. In the special process of welding no cementation is used, but there is a complete fusion of the metals, which gives great strength. As the amount of high-speed steel used is much larger more grinding is possible, which means that the tool has a longer life. The solidity of the tip permits of heavier cuts in machining. The cost is a little more than that of the ordinary tipped tool, but it is claimed that the advantages more than compensate for the difference.

Trade with South America.

Good reports continue to be received of the progress of the Sheffield Trade Mission which is now touring South America, under the leadership of Mr. A. K. Wilson, whose term of office as Master Cutler has just expired. Speaking at a farewell luncheon at the English Club, Buenos Aires, Mr. Wilson expressed the highest satisfaction with the result of the Mission's visit to the Argentine. He said that they would leave Argentina with the feeling that they had accomplished that which they set out to do. Their preconceived idea of the scope of the Argentine market had, since their arrival, been greatly exceeded. They had also made the pleasing discovery that the quality of British goods was still appreciated in Argentina, and they were confident that they would bring more trade to Sheffield.

Cutlery and Plate.

There is a large output of table cutlery and pocket knives in the city, but the trade is not uniformly spread, as an increasing proportion of it comes from the cheap bazaars and from firms which distribute gifts in return for coupons. This means less demand upon the ordinary shopkeeping channels, and firms which cater chiefly for the latter sources are, consequently, short of work and find their turnover down. A similar remark applies to houses which are largely dependent upon the export markets. A number of good contracts are on hand for the equipment of restaurants and trains. The trade in presentation cabinets of cutlery and plate—expensive outfits ranging in value from £10 to £100 or more—is steadily maintained. When the Rt. Hon. R. B. Bennett, Prime Minister of Canada, visited Sheffield last week to receive the Honorary Freedom of the City, the Corporation presented him with a cabinet of Spanish mahogany, manufactured by Joseph Rodgers and Sons, Ltd., containing 111 pieces—sterling silver-handled cutlery with stainless blades, sterling silver forks and spoons.

Airport at Doncaster.

There appears to be a great future before Doncaster as an aviation centre, for the Corporation has thrown itself into a scheme for an airport, prepared by Sir Alan Cobham, and has decided to apply for Parliamentary powers in order that it may be carried into effect. The Corporation already possesses a very suitable site of 260 acres, at Low Pastures, which is not far from the centre of the city, and adjacent to the racecourse. The total cost of the scheme is estimated at £120,000, but it is capable of being carried out in three progressive steps, each complete in itself, at a cost of £47,000, £50,000 and £23,000 respectively. Sir Alan Cobham, in a letter to the Corporation explaining his proposals in detail, pointed out that the first stage would consist of preparing the ground and erecting the necessary buildings so that the airport, as such, might receive an Air Ministry licence and be opened for public use. This work should occupy a period of approximately one year from the commencement of operations, and was the responsibility of the County Borough of Doncaster. The second and third stages dealt with the work to be carried out in the future, the final stage visualising the complete airport developed by municipal and private enterprise as and when traffic warranted extension. He also stated that Doncaster is excellently situated in the centre of England, that it is far enough from the hills to be free from difficulties of navigation due to low clouds and that the site has an advantage in being near the centre of the town, and is also a good one for a light plane club and flying school.

Vacuum Cleaners.

In my letter of October 24th, I referred to the question of making vacuum cleaners in this country, at a price competitive with America, and to the difficulties experienced by Viking Sales, Ltd., of Manchester, in getting any British firm to take up the work. Some further progress in the matter can now be reported. The managing director of Viking Sales states that as a result of the publicity given to his remarks many offers have been received, and in a short time the vacuum cleaners will be made in this country. He says that the number of competing firms has been reduced to six, and Sheffield is in the running.

NORTH OF ENGLAND.

(From our own Correspondent.)

More Contracts for Northern Firms.

WHILST optimism regarding the industrial outlook in the North of England must be restrained, there is, nevertheless, ground for satisfaction in the swelling volume of work. A general opinion prevails that the worst of the depression in the heavy industries has been experienced, and that the New Year will witness a marked revival in trade generally. The most encouraging news this week is that two Teesside firms have secured orders, together worth £1,800,000, in connection with the construction of the £3,000,000 steel works to be opened at Pretoria by the South African Iron and Steel Industrial Corporation, Ltd. They are Dorman, Long and Co., Ltd., of Middlesbrough, who, in conjunction with the German firm, Demag A.G., of Duisburg, will be responsible for the construction of the steel smelting shop and rolling mill departments; and Ashmore, Benson, Pease and Co., of Stockton-on-Tees, who will supply the blast-furnace plant. The value of Dorman, Long's order is about £1,500,000.

Ironworks to Restart.

Another pleasing feature of the iron and steel trade position in the North of England is the fact that the Dinsdale Ironworks are to be restarted. The whole of the blast-furnace plant of the Linthorpe-Dinsdale Smelting Company, Ltd., both at Middlesbrough and Dinsdale, has been idle for some months past owing to the trade depression, but one of the four blast-furnaces at Dinsdale is to be rekindled on the production of ferro-manganese. This will increase the number of blast-furnaces operating on the North-East Coast to twenty-five.

Cleveland Iron Trade.

There is little change to record in the Cleveland pig iron trade. Producers adhere to their fixed minimum prices, and report the limited output absorbed by the needs of their own consuming plant, and requirements of home users who have come on to the market for supplies. Continental iron is coming steadily to hand for consumption on Teesside, as is also a certain quantity of Midland iron. Merchants have little opportunity of dealing in Cleveland iron. No. 1 Cleveland foundry iron is 66s.; No. 3 G.M.B., 63s. 6d.; No. 4 foundry, 62s. 6d.; and No. 4 forge, 62s.

Hematite Pig Iron.

Values of East Coast hematite pig iron are inclined to firmness. Both makers and merchants are taking a stronger stand in spite of the unsatisfactory statistical state of this branch. A steady, though only light, home trade is passing, and producers and second hands report occasional small sales to continental customers. There is still pressure to sell, and whilst makers quote 71s. for mixed numbers and 71s. 6d. for No. 1 quality, probably a little less would be accepted for prompt orders.

Ironmaking Materials.

There is little business being done in the foreign ore trade as the works are heavily bought. Sellers still quote 17s. for best Rubio, but as the Bilbao freight is down to 5s., an offer of 16s. 6d. for prompt cargo would not be rejected. Blast-furnace coke is abundant, and consumers are not disposed to pay prices asked. There are sellers of good medium kinds at 17s. delivered to North-East Coast works.

Manufactured Iron and Steel.

There is more movement in the manufactured iron and steel trade, and it would appear that some buyers have found it necessary to replenish their stores. A few big engineering orders have been placed, and they should help to keep the plant in operation. But the total steel output is much reduced, and all the works would welcome a greater influx of orders. All prices are unchanged.

The Coal Trade.

Here and there the Northern coal market shows a better feeling, but it is premature to say that there is any general improvement in the state of business. Collieries would be much better off if they could get contractors to take out their bought quantities, but the difficulty is to find a market for them. Merchants state that coal is so plentiful everywhere that buyers are by no means easy to secure. What increase in the inquiry there has been of late has been for gas fuel. As might be expected at this time of the year, the consumption is greater, and special Durham classes come in for most attention because of their richer properties in residuals. The price is firmer at 15s. 9d. Other grades are steadier. Coking coals are displaying more activity, and sellers are booking up fairly well. Bunkers are in large supply and prices without any strength. Northumberland steam coals are mostly steady, but there is no particular pressure in any department. Some of the Blyth collieries have good turns for the next week or two, but there is need of more trade for all of them. Best qualities are at 13s. 6d., with seconds at 12s. Gas coke is scarce, and in brisk demand for local consumption and for shipment trades, and 21s. 6d. is firmly held. Patent oven coke is quiet, and owing to ample stocks weakly quoted at 17s. to 17s. 6d. Beehive and special grade foundry coke is holding firm at 24s. to 28s.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding and Engineering.

THE last ship to be built at the Dalmuir shipyard of Wm. Beardmore and Co., Ltd., was launched last week. The vessel, the "Pole Star," was built to the order of the Northern Lighthouse Commissioners. In these times of general depression, it is most pleasing to note the placing of a substantial order in this district in the shape of a contract received by Yarrow and Co., Ltd., Scotstoun, for ten Yarrow water-tube boilers, for the London County Council's tramways department electric power station at Greenwich. The firm is busy in other departments, having just secured through the Crown Agents for the Colonies orders for a twin-screw shallow-draught steamer on the Yarrow system, and two lighters. Messrs. Yarrow also have on hand the construction of the largest and most powerful flotilla leader ever built in this country. This vessel, to the order of the Jugo-Slav Government, will be propelled by turbines working in conjunction with Yarrow water-tube boilers. The shaft horse-power will be about 42,000.

Iron and Steel.

General conditions in the iron and steel markets are unchanged. Inquiries have been more prolific of late, and producers have been looking for some material improvement, but few definite orders have come to hand. Wrought iron makers are quieter once again, now that orders for tube skelp for shipment to Canada have been completed. Re-rolled steel bars, too, are most inactive, with prices at £7 7s. 6d. home and £7 5s. per ton export. Pig iron is not improving, and the output from the ten furnaces in blast is quite sufficient to meet all requirements in view of local trade depression and importations of considerable quantities from India and the Continent. Steel makers report a lack of orders on shipbuilding account, and also for general export. Steel sheets are poorly supported at present, especially in respect to galvanised descriptions, owing partly to keen Belgian competition and to the unrest in India. Steel tubes also are poorly specified at present.

Scrap.

The demand for scrap has dwindled, and business is mostly in small lots, with prices showing an easing tendency. Heavy steel scrap is now quoted in the region of 50s. and cast iron machinery at 60s. per ton.

Coal.

The export coal market continues to be adversely affected not only by severe competition abroad, but also by the uncertainty existing as to the effect of the working of the Coal Mines Act and colliery schemes. Shippers will not commit themselves over long periods, and business is mostly of a day-to-day nature. Despite drastic reductions in output almost all descriptions of round fuel are easily obtainable at arranged prices, the only exception at present being first-class Fifeshire steams. Washed treble and double nuts move off with regularity, but smaller sizes are not too well placed. Aggregate shipments amounted to 239,981 tons, against 250,280 tons in the preceding week and 308,301 tons in the same week last year. Home demands are curtailed by weather conditions and trade depression, and collieries have not been able to press for the advance in prices usually imposed at this season of the year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

ANTHRACITE coals continue to present a very steady appearance and shipments are on an active scale, but it would be an exaggeration to say that there is any improvement in the steam coal section as a whole. While one hears of pits stopping, this is offset by the report that others are re-opening, and it may be that the seasonal demand for certain qualities justifies some owners in making a resumption of work at some pits which have been recently idle. On the whole, the position of steam coals displays no change and it is difficult to find any direction in which it can be said that there is any material expansion in the inquiry. An occasional fresh order for South America makes its appearance, but there is no feature. Taking shipments of all qualities of coal from this district last week, the quantity came to only 478,000 tons, which compared with 510,000 tons in the preceding week and with 597,548 tons in the corresponding period of last year. The returns for last week were certainly disappointing, but there is a prospect of a slight improvement for this week, as the tonnage situation is rather better. The week started with only 10 tipping appliances idle, while eight steamers were waiting. There is also the fact that chartering of tonnage last week was slightly more active, though, since then, it has fallen off somewhat. The contraction in operations may have been brought about by two causes. For some directions certainly there are fewer orders in hand, but there are grounds for the belief that an increasing number of shipowners find it impossible to run their tonnage at the low outward rates which prevail, rates in several cases which constitute low records for twenty years. With rates for West Italy, option Naples, at 5s. 6d., Alexandria at 6s. 3d., Algiers at 6s. 3d., Malaga at 7s. 6d., and similar rates for other destinations in the Mediterranean, shipowners are inevitably making losses, and it is certain that the result must be the laying up of tonnage on a greater scale than at the present time. As regards forward business in coals, it is not surprising to find that with the outlook so uncertain operations are rather quiet. Tenders were opened on Monday for 130,000 tons of small coals for delivery to the Portuguese State Railways over the first four months of 1931, but at the time of writing no news is to hand as to whether the business, or any portion of it, has definitely been placed.

Coalfield Affairs.

Is there going to be a strike in the coalfield on December 1st? This is the question that is being asked by inquirers here and abroad. People want to know what is going to happen, and it is impossible to give an answer. The fact that there are such persistent inquiries shows that fears are entertained that there may be such a disaster. For such it will be if a stoppage comes about. Nothing official can be learned as to how negotiations exactly stand. Private views of coalowners vary on the matter. All that can be said is that the joint sub-committee dealing with the question of a new wages agreement will present its report to a meeting of the Conciliation Board on Monday next and on the following day there is to be a conference of the South Wales Miners' Federation representatives to consider the situation. It therefore looks as if next week something more definite regarding the position of affairs will become known. Mr. John Powell, the president of the Cardiff Chamber of Commerce, speaking at the Lord Mayor of Cardiff's luncheon on Monday, asked the question whether we are going to repeat the folly of 1926. At that time Germany had 9 million tons of coal in stock, and the result of that strike was that we bought that coal from the Germans and consolidated their position and enabled them to capture our markets. The position to-day is that again they have 9 million tons of coal in stock on the ground, and a stoppage of work in this country would again assist them to dispose of it and strengthen their competitive position in the markets of the world. Mr. Powell pleaded for a five years' truce between capital and labour and said that if it were arranged they might again see this country brought to a state of permanent prosperity.

The Coal Scheme for South Wales.

Coalowners in this district met on Thursday last week to discuss business in connection with the South Wales District (Coal Mines) Scheme, 1930, which received the Board of Trade's approval on October 28th. Under the terms of the scheme the Executive Board is to consist of 36 persons, of whom 30 are to be appointed by the South Wales Coal Marketing Association, and six by owners who are not members of the Association. The names of those gentlemen who have been appointed to serve were subsequently announced, and Mr. W. North Lewis was elected chairman, with Mr. T. P. Cook as vice-chairman. There was also an adjourned meeting of the owners on Monday, when the names were announced of the seven representatives elected to represent the district on the Central Council which will administer the Central Scheme.

Traffic at South Wales Ports.

Returns issued by the Great Western Railway Company respecting the traffic at the six ports in this district under its control show that for the four weeks ended October 26th imports and exports came to 2,650,626 tons, which was a slight improvement upon the total for the preceding month, when the total was 2,611,159 tons, but compared with the corresponding period of last year, there was a decline of 411,027 tons. Taking the whole of this year to October 26th, imports and exports aggregated 29,250,853 tons, as against 31,667,261 tons, a decline of 2,416,408 tons.

North Wales Coal Audit.

For the three months ended September, the audit of the North Wales coalfield shows a deficit balance of £3445, equivalent to 1·04d. per ton on an output of 799,923 tons. The proceeds realised amounted to £510,485, which represents 12s. 9·16d. per ton, but costs were £513,940, equal to 12s. 10·20d. The economic wage certified was 101·04 per cent. of the basis rates and the payment of the minimum rate of 22 per cent. above the basis rates involved the owners in a deficiency of £73,212, thus increasing the deficiency carried forward to £3,514,124. The output per man-shift worked was 18·22 cwt. and the average wage per man-shift worked 8s. 4·09d.

Current Business.

Steam coal market conditions have not appreciably altered in the past week. The supply of both large and small coals continues to be excessive, with prices on the minima, but there is a steady demand for sized qualities. The patent fuel and coke markets remain quiet, and pitwood displays no new feature, with prices round about 24s. 9d. to 25s.

CATALOGUES.

CARRON COMPANY, Carron, Falkirk.—Season 1930–31 electric fire catalogue.

FERODO LTD., Chapel-en-le-Frith.—"Ferodo Linings for Friction Wheel Transmission."

CROMPTON PARKINSON, Ltd., Guiseley, Leeds.—Specification No. A505 on kiosk type sub-stations.

A. REYROLLE AND CO., Ltd., Hebburn-on-Tyne.—Pamphlet No. 182, describing split-conductor protection.

J. BLAKEBOROUGH AND SONS, Ltd., Brighouse, Yorks.—Catalogue No. 115 on Larner-Johnson valves for waterworks.

GEORGE ELLISON, Ltd., Perry Barr, Birmingham.—"Industrial Applications of Small Ellison Circuit Breakers and Starter."

MARSHALL, SONS AND CO., Ltd., Gainsborough.—Publication No. 2112, Section 25, of special engines and boilers for educational purposes.

DOBBIE MCINNES AND CLYDE, Ltd., 57, Bothwell-street, Glasgow.—"Indicators and Accessories for Steam and Diesel Engines."

G. A. HARVEY AND CO., Ltd., Woolwich-road, S.E. 7.—Catalogue 464 of perforated metals for screening, grading, cleaning, sorting, &c.

BUCK AND HICKMAN, Ltd., 2, Whitechapel-road, E. 1.—The new 1140-page general catalogue of engineers' tools and supplies of all types.

EDGAR ALLEN AND CO., Ltd., Sheffield.—Second edition of the firm's mine and quarry plant book.—Also a brochure on "Stag" ore crushers and stone breakers.

STURTEVANT ENGINEERING COMPANY, Ltd., 147, Queen Victoria-street, E.C. 4.—Catalogue 1096, "Wood Dust Collecting;" 1097, "General Dust Collecting."

FERRANTI LTD., Hollinwood, Lancs.—Publication W522, "The Construction of Supply Units for Radio Receivers;" W522/1, "Ferranti Mains Components."

CROSSLEY BROS., Ltd., Openshaw, Manchester.—Two of the latest publications: 1240B, "Vertical Compressorless Diesel Engines;" 1313A, "Enclosed Horizontal Heavy-oil Engines."

G. AND J. WEIR, Ltd., Cathcart, Glasgow.—Catalogue, Section I, dealing with feed pumps, feed heaters, &c., for marine work, and a booklet giving some examples of "Weir" high-pressure boiler feed pumps.

CONSOLIDATED PNEUMATIC TOOL COMPANY, Ltd., 170, Piccadilly, W. 1.—The following publications:—S.P. 152, Economical Road Breaking Work; S.P. 153, Pneumatic and Electric Publication; S.P. 154, Tie Tamper; S.P. 155, CP-146 Stoper; Electric Tool Catalogue No. 16; Pneumatic Tool Catalogue No. 45.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

JOHN CASHMORE, of Town Dock, Newport, Mon., asks us to announce that he has purchased the Birchgrove Steelworks, Swansea. The work of demolition has been begun, and will give employment to a large number of men for some considerable time.

GEORGE COHEN SONS AND CO., Ltd., of 600, Commercial-road, London, E., inform us that they have acquired the materials resulting from the demolition of the metre-gauge Aden State Railway, which has recently been abandoned, together with the whole of its rolling stock and other accessories and equipment.

THE INCINERATOR COMPANY, Ltd., asks us to announce that it has changed its address from Walter House, Bedford-street, Strand, London, W.C. 2, to Hatcham Ironworks, Pomeroy-street, New Cross, London, S.E. 14. Its new telephone number is New Cross 0668, and its telegraphic address "Clinkers, 'Phone, London."

THE MARCONI INTERNATIONAL MARINE COMMUNICATION COMPANY, Ltd., asks us to announce that an agreement has been arrived at between it and the Chamber of Shipping of the United Kingdom and the Liverpool Steamship Owners' Association regarding the terms under which the Marconi Marine Company is prepared to carry out marine wireless on British ships in the future. As a part of this arrangement the Marine Company agreed to appoint to its board of directors a member to be nominated by the shipping industry, and it was unanimously decided on behalf of the two shipping organisations to nominate the Hon. Alexander Shaw. Mr. Shaw is a deputy chairman of the P. & O. Steam Navigation Company and a Director of the Bank of England.

CONTRACTS.

YARROW AND CO., Ltd., of Scotstoun, Glasgow, have received an order from the London County Council for ten Yarrow boilers for the Tramways Department electric power station at Greenwich. The value of this order is over £200,000.

THE HYDRAULIC ENGINEERING COMPANY, Ltd., of Chester, has received from the Great Western Railway an order for a 30-ton movable coal hoist and traverser for the Queen Alexandra Dock, Cardiff. This is the fifth hoist of this particular type to be manufactured by the firm for that dock.

THE TAYLOR STOKER COMPANY, Ltd., of Bush House, London, W.C. 2, has received an order for two Taylor underfeed stokers in connection with the extensions to the steam-raising plant at the Stourport station of the Shropshire, Worcestershire and Staffordshire Electric Power Company. These stokers will each fire a boiler with an evaporative capacity of 100,000 lb. per hour.

DORMAN, LONG AND CO., Ltd., of Middlesbrough and London, have received from the Mersey Docks and Harbour Board an order for the supply and erection of three rolling bascule bridges at Liverpool, the inclusive price being £96,969. Two of these bridges will carry railway and road accommodation and have openings of 70ft. 3in., whilst the third will have road accommodation only and an opening of 51ft.

WILD-BARFIELD ELECTRIC FURNACES, Ltd., of Elecfurn Works, North-road, Holloway, London, N. 7, has just received an order from manufacturers in this country for several Gibbons-Wild-Barfield electric furnaces. The contract is believed to be the largest ever placed in this country for electric resistance furnaces, two of which will be the largest ever built in Great Britain, each having a capacity of 7 tons.

J. BLAKEBOROUGH AND SONS, Ltd., of Brighouse, Yorks., have received an order for two "Blakeborough" twin-fold travelling screens, each 5ft. wide by approximately 57ft. long, including the necessary driving gear, &c., the total capacity of the screens being 4,527,500 gallons of water per hour, for the new Ford works at Dagenham. In addition to the travelling screens, there are included in the order four electrically-operated rectangular sluice gates, each 3ft. wide by 8ft. deep, and one 7ft. diameter circular sluice gate for electric operation.

INSTITUTION OF NAVAL ARCHITECTS: DUKE OF NORTHUMBERLAND PRIZE.—The Council of the Institution of Naval Architects has awarded the Duke of Northumberland Prize in connection with the 1930 examinations for National Higher Certificates in Naval Architecture, to Mr. Laurence Barton Hislop, of the Royal Technical College, Glasgow.

CLOSURE MADE ON 1652FT. KILL VAN KULL STEEL ARCH.—From the issue of the *Engineering News-Record* of October 9th we cull the following information:—On Saturday, October 4th, at 4 p.m., the two arms of the 1652ft. steel arch span of the Kill van Kull bridge being erected between Bayonne, N.J., and Staten Island, New York City, were joined and swung free from their falsework bent supports. With the lower chords thus joined, the most important erection operation has been safely accomplished, and after the closing top chord member is inserted, some time this week, completion of the bridge will be a routine matter. Steel erection began in January of this year, so that progress has been remarkably rapid. The Kill van Kull arch is by far the longest arch yet erected on falsework bents. It is also notable because the closure joint was located seven panels beyond the centre of the arch, a requirement made necessary by the location of a ship channel near one shore in which no falsework could be placed. The erection scheme followed was to cantilever successively from steel bents placed and released as erection progressed. At the time of closing one side consisted of an anchor arm and cantilever arm, each 289ft. long, while on the opposite side the anchor arm was 661ft. long and the cantilever arm 413ft. long. Closure was made on an 8in. diameter pin in the lower chord of each truss. On account of subnormal temperatures at the time of closing, the initial gap between the two arms was about 12in., considerably more than expected. However, the carefully planned closure mechanism—namely, jacks in the top of the falsework bents—functioned perfectly. In about 24 hours elapsed time and in less than half that of actual working time, the gap was closed and the bents were released. The Kill van Kull bridge was designed by and is being erected under the supervision of the Port of New York Authority as a toll highway structure. The American Bridge Company is the fabricator and erector.

THE INSTITUTION OF ENGINEERING INSPECTION.—Speaking at the annual dinner of the Institution of Engineering Inspection at the Connaught Rooms, London, on November 5th, Sir Arthur Balfour, proposing "The Institution," said it was time we recognised that we were approaching a period of real national economic peril, and it was essential that we should cut out all politics and have a Coalition Government as we had during the war, because it was heartbreaking to see our politicians fiddling with politics in the same way that was done 100 years ago, whilst our economic position was burning away. He did not know how long it would take the House of Commons to find out that the country is really facing a serious economic situation. Sir William J. Larke (Director, National Federation of Iron and Steel Manufacturers), proposing the toast of "Inspection," said it was now generally recognised that the difficulties of industry in this country are due to causes entirely external to industry. It was no use glibly blaming the industrialist for conditions which were not only international, but, so far as this country was concerned, were also national in character and often political in origin. Sir William then suggested to the members of the Institution that they could help manufacturers in a vital manner. The manufacturers were frequently called upon to comply with a wide range of inspection requirements, and if that blessed word "rationalisation" could only be applied to inspection, and inspecting engineers could co-operate in such a manner as to give a national inspection service, so that inspection and production could progress together, it would assist tremendously in increasing the competitive power of this country and in enabling manufacturers to reduce their costs. Mr. H. J. Davey (past-President), responding, remarked that works in Great Britain—where apparently no rationalisation of orders existed—were often asked to roll a small tonnage of special sections and qualities, and were faced with the accusation of lack of enterprise if they refused, and the cost of cutting special rolls and making special casts of steel if they accepted. If only design would consult inspection more freely before drawing up a specification in the office without an accurate knowledge of works arrangement, some of this worry might be saved.

THE INSTITUTION OF HEATING AND VENTILATING ENGINEERS: KELVIN THEORY IN PRACTICE.—"The development of heat engines has been so considerable that it may be well worth while to reconsider our heating methods in the light of Lord Kelvin's principles," said Mr. T. G. N. Haldane, M.A., A.M.I.E.E., at a meeting of the Institution of Heating and Ventilating Engineers. The ideas were by no means novel, since they were originally conceived in the middle of last century by Lord Kelvin, and are well known to all who have studied the theory of heat engines. At the present time, artificial heating can be carried out either by burning fuels in various types of furnaces or by using electrical energy. Hitherto, we have failed to distinguish clearly the inherent difference between electrical energy and ordinary fuel as a means of heating. Whereas a unit of electricity can be converted into mechanical energy with great ease and little loss, a pound of fuel cannot readily be converted into mechanical energy without considerable loss. A given quantity of mechanical energy can be made to produce a very much larger amount of heat energy. To achieve this object we must use the mechanical energy to drive a reversed heat engine, whose function is to draw heat from the limitless heat of our surroundings and by raising its temperature make it available for actual heating purposes. The most familiar type of heat pump is the refrigerator. The process of producing cold is simply that of pumping heat from a relatively cold, to a relatively hot source, but in this process particular attention is paid to the prevention of the leakage of heat into the cold source, whereas no attempt is made to prevent the escape of heat from the hot source. If a refrigerating plant were to be treated as a heat pump in which the primary product is the heat rejected to the hot source, the order of importance would be reversed, and every opportunity would be given for the leakage of heat into the cold source, and every precaution taken to prevent leakage of heat from the hot source. Apart from this and minor differences in the temperature ranges over which the plant would work, a refrigerator is precisely the type of heat pump for the purpose of heating buildings or swimming baths. It lends itself particularly to heating systems utilising a low temperature of circulating water.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	17/9 to 20/6
(1) Spanish	20/6 to 21/–
N.E. Coast—	
Native	18/– to 21/–
Foreign (c.i.f.)	17/–

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 17 0	—
No. 1 Foundry	3 19 0	—
No. 3 Foundry	3 16 6	—
N.E. Coast—		
Hematite Mixed Nos.	3 11 0	3 11 0
No. 1	3 11 6	3 11 6
Cleveland—		
No. 1	3 6 0	3 6 0
Siliceous Iron	3 6 0	3 6 0
No. 3 G.M.B.	3 3 6	3 3 6
No. 4 Foundry	3 2 6	3 2 6
No. 4 Forge	3 2 0	3 2 0
Mottled	3 1 6	3 1 6
White	3 1 6	3 1 6
Midlands—		
(c) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 8 6	—
,, ,, Foundry	3 13 6	—
(c) Northampton—		
Foundry No. 3	3 10 0	—
Forge	3 5 0	—
Derbyshire—		
No. 3 Foundry	3 13 6	—
Forge	3 8 6	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 3 6 (*a*) / 4 5 6 (*b*) / 4 10 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
Lancs.—		
Crown Bars	10 5 0	—
Second Quality Bars	8 15 0	—
Hoops	13 0 0	—
S. Yorks.—		
Crown Bars	10 5 0	—
Best Bars	11 0 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	10 0 0 to 10 7 6	—
Marked Bars (Staffs.)	12 10 0	—
Nut and Bolt Bars	9 0 0 to 9 5 0	—
Gas Tube Strip	10 17 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine)	10 10 0	10 10 0
,, ,, (Land)	10 0 0	10 0 0
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	8 15 0	8 15 0
Sheets (Gal. Cor. 24 B.G.)	11 15 0	11 12 6

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
,, ,, (Land)	10 0 0	—
Joists	8 10 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	—
Billets	6 15 0 to 9 10 0	—
Manchester—		
Bars (Round)	9 7 6	—
,, (Small Round)	7 7 6 to 7 10 0	—
Hoops (Baling)	10 0 0	9 15 0
,, (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
,, (Lancs. Boiler)	9 10 0	—
Sheffield—		
Siemens Acid Billets	9 10 0 (basis)	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	6 10 0	—
Hoops	10 5 0	—
Soft Wire Rods	8 0 0	—
Midlands—		
Small Rolled Bars	7 12 6 to 8 10 0	—
Billets and Sheet Bars	5 15 0 to 6 5 0	—
Galv. Sheets, f.o.b. L'pool	11 12 6	—
(2) Staffordshire Hoops	10 0 0	—
Angles	8 7 6	—
Joists	8 10 0	—
Tees	9 7 6	—
Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14 f.o.b.	17/–
Block Tin (Cash)	111 10 0
,, (three months)	112 17 6
Copper (cash)	44 10 0
,, (three months)	44 12 6
Spanish Lead (cash)	15 10 0
,, ,, (three months)	15 11 3
Spelter (cash)	14 10 0
,, (three months)	15 1 3
Manchester—	
Copper, Best Selected Ingots	46 0 0
,, Electrolytic	48 0 0
,, Strong Sheets	73 0 0
,, Tubes (Basis Price), lb.	0 0 11
Brass Tubes (Basis Price), lb.	0 0 10
,, Condenser, lb.	0 1 0
Lead English	17 5 0
,, Foreign	15 12 6
Spelter	15 5 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/6 per lb.	
Ferro Tungsten	2/3 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 5 6	7/–
,, ,, 6 p.c. to 8 p.c.	£22 10 0	7/–
,, ,, 8 p.c. to 10 p.c.	£22 0 0	7/–
,, ,, Specially Refined		
,, ,, Max. 2 p.c. carbon	£33 0 0	10/–
,, ,, ,, 1 p.c. carbon	£38 0 0	13/–
,, ,, ,, 0·70 p.c. carbon	£41 0 0	14/–
,, ,, ,, carbon free	11d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£11 15 0 for home	
,, ,, ,,	£11 5 0 for export	
,, Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/– per unit	
,, ,, 75 p.c.	£18 0 0 scale 7/– per unit	
,, Vanadium	12/9 per lb.	
,, Molybdenum	4/2 per lb.	
,, Titanium (carbon free)	11d. per lb.	
Nickel (per ton)	£170 to £175	
Ferro Cobalt	9/6 per lb.	

FUELS.

SCOTLAND.

(*Prices not stable.*)

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	12/6
,, ,, Ell	13/9
,, ,, Splint	14/– to 15/3
,, ,, Trebles	12/6
,, ,, Doubles	12/–
,, ,, Singles	10/6
Ayrshire—	
(f.o.b. Ports)—Steam	13/–
,, ,, Jewel	16/–
,, ,, Trebles	13/–
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	10/9 to 12/–
Screened Navigation	16/6 to 17/6
Trebles	13/6 to 16/–
Doubles	12/6
Singles	10/9
Lothians—	
(f.o.b. Leith)—Best Steam	11/–
Secondary Steam	10/9
Trebles	13/3
Doubles	12/–
Singles	10/9

ENGLAND.

	Inland.
(8) N.W. Coast—	
Steams	20/6 to 21/–
Household	32/6 to 53/6
Coke	21/– to 22/–
Northumberland—	
Best Steams	13/6
Second Steams	12/–
Steam Smalls	10/– to 10/6
Unscreened	12/6
Household	25/– to 37/–
Durham—	
Best Gas	14/9 to 15/–
Second	12/9 to 13/–
Household	25/– to 37/–
Foundry Coke	24/– to 26/–
Sheffield—	Inland.
Best Hand-picked Branch	25/6 to 27/–
Derbyshire Best Bright House	20/– to 22/6
Best House Coal	19/6 to 20/6
Screened House Coal	17/6 to 19/–
,, ,, Nuts	14/6 to 16/6
Yorkshire Hards	14/– to 15/6
Derbyshire Hards	14/– to 15/6
Rough Slacks	8/6 to 9/–
Nutty Slacks	6/6 to 7/–
Smalls	3/– to 5/–
Blast-furnace Coke (Inland)	11/– on rail at ovens
Furnace and Foundry Coke (Export), f.o.b. 16/6 to 17/–	

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	20/–
Second Smokeless Large	18/9 to 19/9
Best Dry Large	18/6 to 18/9
Ordinary Dry Large	17/6 to 18/–
Best Black Vein Large	18/3 to 18/6
Western Valley Large	18/– to 18/3
Best Eastern Valley Large	17/7½ to 17/9
Ordinary Eastern Valley Large	17/6 to 17/7½
Best Steam Smalls	13/3 to 13/6
Ordinary Smalls	11/6 to 12/9
Washed Nuts	17/6 to 21/6
No. 3 Rhondda Large	20/– to 20/6
,, ,, Smalls	15/6 to 16/–
No. 2 ,, Large	17/– to 17/3
,, ,, Through	16/– to 16/6
,, ,, Smalls	14/– to 14/3
Foundry Coke (Export)	27/6 to 35/–
Furnace Coke (Export)	17/6 to 20/–
Patent Fuel	21/6
Pitwood (ex ship)	24/9 to 25/–
Swansea—	
Anthracite Coals:	
Best Big Vein Large	35/– to 37/6
Seconds	27/– to 31/6
Red Vein	23/6 to 27/–
Machine-made Cobbles	41/6 to 45/–
Nuts	40/– to 46/–
Beans	24/6 to 27/6
Peas	21/– to 21/6
Breaker Duff	9/9 to 10/3
Rubbly Culm	9/3 to 9/9
Steam Coals:	
Large	19/6 to 21/6
Seconds	18/– to 19/6
Smalls	12/– to 13/–
Cargo Through	15/6 to 16/–

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate: Joists (minimum), 12/6; Ordinary Ship, Bridge, and Tank Plates and Sections, 10/– if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

French Engineering Notes.

(From our Correspondent in Paris.)

Iron and Steel Production.

At a time when the condition of the steel trade shows the desirability of restricting production and reducing stocks, it is curious to observe in the statistics of output during September last that, compared with September, 1929, there was an increase in nearly all districts except Alsace-Lorraine, where the contraction was so great as to leave a decline in the general total. The output of pig iron was 801,000 tons, as compared with 844,000 tons. The number of furnaces in blast was 140, as against 157. The production of pig iron in Alsace-Lorraine fell from 317,000 tons to 268,000 tons. The production of semi-manufactured steel in September amounted to 767,000 tons, a decline of 3000 tons as compared with the figure for September, 1929, though the average monthly production for that year was 808,000 tons. Here, again, the steel production in Alsace-Lorraine declined from 239,000 tons to 226,000 tons, while in all other districts, except the Ouest, there were increases. As regards rolled iron and steel there were produced in September, 49,000 tons of rails and 17,000 tons of steel sleepers, which was notably more than a year ago, but there was a heavy drop in joists to 60,000 tons, and also in rods to 22,000 tons. The production of merchant bars increased to 200,000 tons, and thick sheets rose to 33,000 tons, but thin sheets fell somewhat heavily to 54,000 tons. Now that the Steel Cartel has been prolonged until the end of the year, the French production of steel will have to be reduced in order to avoid the payment of penalties for any excess over the quota. Some reduction is inevitable in view of the continual weakness of trade on the home market, and steel makers are anxious to renew the Cartel because they look forward to a larger demand for their material when the national programme of public works is resumed, and they will then be quite prepared to pay penalties for exceeding their quota if, by so doing, they can secure a monopoly of their own market. The dissolution of the Phosphoric Pig Iron Producers Syndicate has helped to depress the market. Prices have fallen considerably, and it is declared that supplies are being offered in the Midlands at specially low rates.

The Motor Car Industry.

Motor car manufacturers are confronted with the problem of extricating themselves from an extremely difficult situation. Since the slump set in towards the close of last year, things have been going from bad to worse. For the time being, the market appears to have absorbed all it can of new cars, and a great number of purchasers content themselves with buying second-hand vehicles. Moreover, the traffic congestion tends to check the purchase of cars for town use. Although there still remain a score or so of manufacturers, about two-thirds of the business is in the hands of three or four makers who, with their mass production, depend largely upon the foreign trade, and as that has diminished considerably, the old scheme for bringing back a normal activity to the automobile industry by means of rationalisation and other methods is being discussed. Attempts to do that have so far failed. The leading makers are now endeavouring to carry out a continental combination, particularly in the way of restricting types of cars and of delimiting the markets for each country. There have been negotiations for that purpose, without definite results, except the formation of an international bureau which brings all the continental makers into direct contact, and it is hoped that the urgent necessity of doing something to put the continental industry on a more satisfactory basis will remove some of the difficulties that have so far stood in the way of a continenal combine.

Sea-water Power.

The failure of Monsieur Georges Claude to secure more than a very small quantity of energy for a huge expenditure of money upon his installation in the Matanzas Bay, Cuba, has left the engineering world sceptical of his ultimate success. The enthusiasm which followed the announcement that his experimental plant was working and producing energy has waned and few engineers are taking the scheme seriously. Monsieur Claude himself has not lost confidence, and in an account of his experiments to the Académie des Sciences he attributed the poor results obtained to the temperature of the water at the bottom of the sea being higher than he had supposed. He declared that with a greater difference of temperature, since the efficiency is proportionate to the square of that difference, he could obtain 330 kW with a delivery of 1 cubic metre of water per second, and that, with certain improvements suggested by his experiments, that figure could be increased to 580 kW. He also informed the Academy that the new power station, to be laid down at a place where he was assured of a much greater difference in temperatures, would produce from 25,000 kW to 30,000 kW, and its cost would be something like 100 million francs.

Trade Reforms.

The report presented by the French Conseil National Economique to the Economic Conference at Geneva upon the methods to be adopted to facilitate trade relations between countries, implies that the process for attaining that end may be a very long and tedious one. The French do not believe in partial expedients. They point to the danger of attempting to bring about any upheaval of the present situation. The Conference must go to the root of the matter and discover the causes of the present economic difficulties and then deal with them progressively. In a word, the French programme provides for interminable negotiations with countries, the interests of which are nearly all in opposition, and the chances of anything being done along these lines within a reasonable time are very remote.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

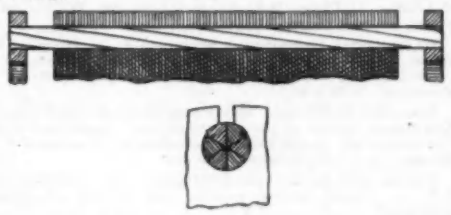
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

336,134. November 13th, 1929.—Winding for Dynamo-electric Machines, *The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C. 2.*

In order to reduce eddy current losses in the copper of squirrel-cage motors the inventors make the bars of segmental shaped

N°336,134



strands insulated from one another and twisted together. The amount of the twist is preferably 360 deg. or some multiple thereof. The bars are not necessarily insulated from the laminations of the core, and are pressed in place so that they make good mechanical contact and their heat is conveyed away by conduction.—*October 9th*, 1930.

MACHINE TOOLS AND SHOP APPLIANCES.

334,912. June 12th, 1929.—Machines for Straightening Rods and Pipes, T. W. Hartley, Great Bents, Oaken, near Codsall, Wolverhampton.

This straightening machine is of the type in which the rod, or tube, is passed between two driven angular rolls A and A and three idle rolls B, C, D. Of these three C is a pressure roll. The

N°334,912

Fig. 1.

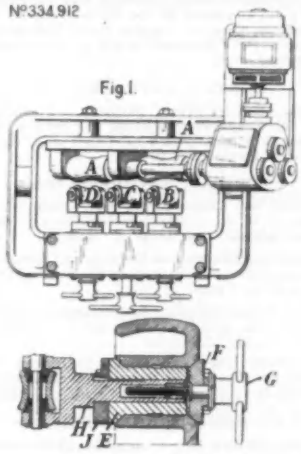


Fig. 2

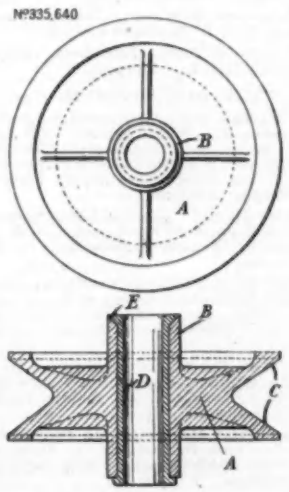
invention consists in the arrangements for adjusting the three rolls. They are adjustable along the length of the bed by sliding the block E—see Fig. 2—in a slot and clamping it by the plate F. They can be moved forward by the hand wheel and screw G, and can be set as to angularity by rotating the stalk H and locking it with the plate J.—*September 12th*, 1930.

MOTOR CARS AND ROAD TRAFFIC.

335,640. July 4th, 1929.—Trolley Wheels for Collecting Electricity, Ernest Henry Hill, of Beta Works, 56, Broomhall-street, Sheffield.

The object of this invention is to prolong the life of trolley

N°335,640



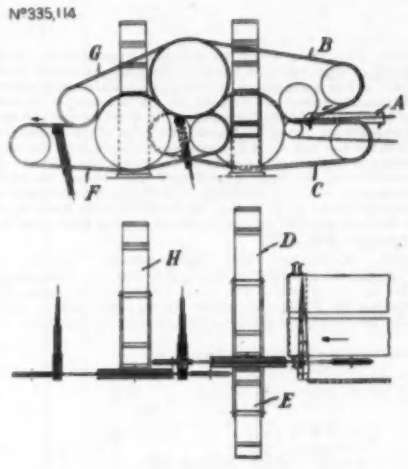
wheels, and the object is secured by the use of suitable materials at the places where the greatest wear occurs. The main portion A of the wheel is cast with a central hub B, and a flanged or grooved circumference C. This main portion of the trolley wheel is cast of an alloy designed to resist wear due to arcing and friction, and the following is the preferred composition:—Copper, 60 per cent.; zinc, 24 per cent.; nickel, 5 per cent.; aluminium, 5 per cent.; lead, 4 per cent.; iron, 2 per cent. The hub portion B is lined with a bush D of phosphor bronze or other alloy, capable of providing an efficient bearing surface. The bush may be forced into the hollow hub by pressure and may be further secured by riveting or spinning its ends over the metal of the hub. In Fig. 2 one end of the hub is countersunk, as shown at E and the bush is riveted therein, whilst the other end of the bush is spun over the hub portion.—*October 2nd*, 1930.

MISCELLANEOUS.

335,114. November 15th, 1929.—Decorticators, Fried. Krupp Grusonwerk Aktiengesellschaft, Magdeburg-Buckau, Germany.

In this decorticating machine an effort is made to scutch the leaves entirely in the direction of the fibre. The leaves are brought into the machine on the conveyor A and are caught between the two conveyor belts B and C at a point some 20 cm.

N°335,114

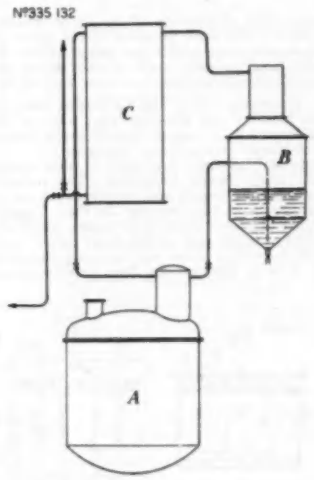


to 30 cm. from their root ends. They are passed between two beater drums, and their breasts D and E, which clean the two ends of the leaves of their pulp. There then remains the necessity to clean that part of the leaf which has been gripped by the conveyor. This is effected by taking another grip on the cleaned fibre by another conveyor system F G, out of line with the first conveyor, and subjecting the leaf to another beating by a third drum H.—*September 18th*, 1930.

335,132. December 19th, 1929.—Process for the Production of Alcohol Free from Water, Zellstoff-fabrik Waldhof, Mannheim-Waldhof, and O. Luhrs, Sandhoferstrasse 180, Mannheim-Waldhof, Germany.

This invention is concerned with the production of absolute alcohol free from any cloudiness caused by the carrying over from the rectification vessel of colloidal chalk used in the rectifica-

N°335,132



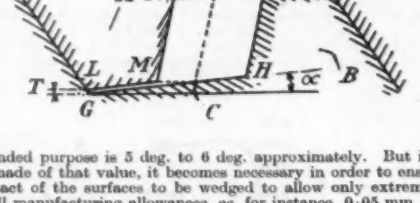
tion process. The alcohol of a quality of about 94 per cent. is treated in the autoclave A with a charge of calcined chalk at a pressure of about 3 atmospheres and heated, with stirring, if necessary, for about 1½ hours. When the alcohol is free from water it is distilled off and is bubbled through a bath of absolute alcohol in the chamber B. This process is said to effect the complete removal of the chalk and the vapour is condensed in the condenser C.—*September 18th*, 1930.

335,598. June 25th, 1929.—Lock Nuts, British Dardelet Threadlock (D.D.G.) Corporation, Ltd., 42, Kingsway, in the County of London.

This invention relates to screw threads, and more particularly to screw threads in which a screw-threaded female member is incapable of slackening back as the result of accidental causes. A screw thread is known, which is applicable to a male element, such as a bolt, and to a female element, such as a nut, the profile of which screw thread is characterised in that the bottom of the thread of one element is generated by a straight line inclined relatively to the axis of the bolt or nut at an angle which is small enough to allow the apex or top of the screw thread of the other or mating element—also generated by an inclined straight line—to press strongly against the bottom of such screw thread, by reason of the reaction of the parts to be clamped during the tightening up of the nut or female element, the latter if the angle be small enough becoming wedged on the male element. Such a screw thread is shown in vertical section in the drawing, in which A represents the nut and B the bolt, the common axis of the nut and the bolt being horizontal in the figure and the head of the bolt being presumed to be on the left-hand side of the figure, so that, as the result of clamping during tightening up of the nut, the latter, owing to resultant end pressure, is displaced relatively to the bolt in the direction indicated by the

arrow F. For the purpose of producing this wedging effect, the condition to be fulfilled for pitches p, which are relatively small in comparison with the diameter D of the screw-threaded rod ($p < 1/8\ D$) is approximately that the angle α, which the straight line generating the bottom of the thread makes with the axis, is such that $\tan \alpha < f$, where f is the coefficient of friction of the metals in contact. The smaller α is the smaller is the pressure component which tends to move the wedged nut in the opposite direction to that of the arrow F; that is to say, towards the bottom of the slope formed by the inclination α, and consequently the more rigidly is the nut wedged on the screw-threaded bolt body. In practice a suitable value of α for the

No335,598

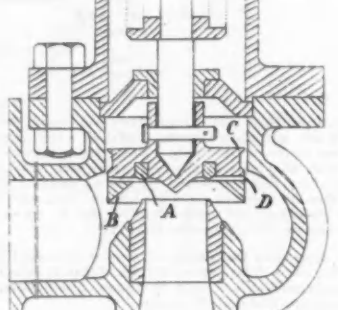


intended purpose is 5 deg. to 6 deg. approximately. But if α be made of that value, it becomes necessary in order to ensure contact of the surfaces to be wedged to allow only extremely small manufacturing allowances, as, for instance, 0·05 mm. for a screw thread of 24 mm. diameter. It must, in fact, be assured that at least on one of the threads the tops of the threads—such as L, M for the nut A—will come into contact with the opposite bottoms of the threads—such as G, H on the bolt B—which are inclined at an angle α, and that this contact be produced early enough, at C for instance, so that the final pressure of the inclined portions L, M, and G, H, be sufficiently great to ensure that the bolt and nut cannot be de-wedged by accidental causes.—*September 25th*, 1930.

335,800. November 14th, 1929.—Safety Valves, L. F. Norrie, 30, South Fort-street, Bonnington, Edinburgh.

This safety valve is of the quick-lift type. The valve A has a depending lip B, against which the escaping steam impinges, and by its reaction accelerates the opening of the valve. There

No335,800



is also a piston-like extension C of the valve, which works in a cylinder above. The back pressure in the outlet branch acts on this piston and helps to lift the valve. Ports D are drilled in the valve, and by-pass some of the steam as the valve approaches the closing position.—*October 2nd*, 1930.

335,829. December 5th, 1929.—Condenser Batteries, Hirsch, Kupfer- und Messingwerke, A.G., of Messingwerk, near Eberswalde, Germany, and Heraeus Vacuumschmelze A.G., of Hanau on the Main, Germany.

The condenser batteries described in this specification are intended for power factor correction. The elements are contained in an oil-filled vessel, and cooling tubes are provided for the circulation of a cooling medium. In Figs. 1 and 2 the wound elements A are placed in an oil-filled vessel, which is closed by a cover B. In the upper part of the vessel bars C are fastened to the walls of the vessel, these bars carrying the cooling tube D by means of tube clips E. In Fig. 3 the condensers consist

No335,829 Fig.1

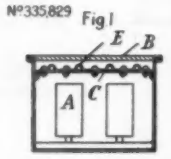


Fig.2.

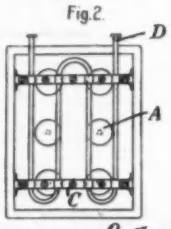
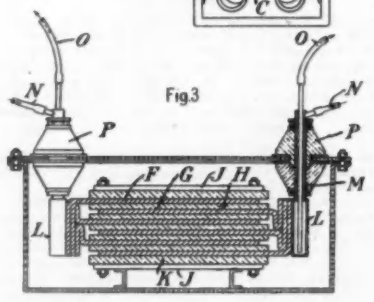


Fig.3



of coatings F and G, separated by the dielectric H. The coatings and the dielectrics are terminated by plates J pressed together by screws. Between the plates and the coatings insulating plates K are provided. The coatings F are brought out at one end of the condenser and the coatings G at the other end, each set of the brought-out parts being grouped together and soldered. To these soldered ends of the coatings hollow cylinders L are sweated which are connected to double tubes M. The cooling medium is led to the outer part of the tube by the pipe N, and led away from the inner part of the tube M by the pipe O. The cooling tube M serves at the same time as leading-in conductor, and is therefore led through the cover by bushing insulators P.—*October 2nd*, 1930.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Chadwick Public Lectures.—Lecture Room of the Royal Institute of British Architects, 9, Conduit-street, W. 1. "The Object and Methods of Sewage Treatment, particularly in relation to Inland Towns and Isolated Institutions," by Mr. J. H. Coste. 8.15 p.m.

Chemical Engineering Group: London Section.—Joint Meeting with Newcastle Section. 3.50 p.m., visit to the Carville Power Station of the Newcastle-upon-Tyne Electric Suppy Company, Ltd.; 6.30 p.m., joint meeting in Armstrong College, Newcastle. "Caustic Embrittlement," by Mr. W. S. Coates. 8 p.m., informal dinner.

Illuminating Engineering Society.—At the House of the Royal Society of Arts, John-street, Adelphi, London, W.C. "The Lighting of Offices and Public Buildings," by Mr. J. A. Macintyre. 6.30 p.m.

Institute of Metals: Sheffield Local Section.—In the Non-ferrous Section of the Applied Science Department of the University, St. George's-square, Sheffield. "Unsoundness in Metals," by Mr. H. Hyman. 7.30 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Annual general meeting and election of officers. 7.30 p.m.

Keighley Association of Engineers.—Queen's Hotel, Keighley. "Salving the ex-German Fleet at Scapa Flow," by Mr. E. F. Cox. 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—In the Lecture Theatre of the Mining Institute, Newcastle-on-Tyne. "Disembarkation of Passengers in Emergency at Sea," by Mr. E. F. Spanner. 6 p.m.

TO-DAY TO SATURDAY, NOVEMBER 22ND.

South Wales Institute of Engineering.—Drill Hall, Dumfries-place, Cardiff. Exhibition.

SATURDAY, NOVEMBER 15TH.

Institution of Municipal and County Engineers.—South-Eastern District meeting at Heathfield. 11.45 a.m., assemble at Heathfield Station; 12 noon, proceed to Outfall Works of Heathfield Main Drainage and Sewerage Disposal Works; 2 p.m., luncheon at the Railway Hotel, followed by discussion on the papers: "Some Rural Difficulties," by Mr. W. O. Humphery; "Practical Notes on Supervision," by Mr. G. H. Ockenden.

MONDAY, NOVEMBER 17TH.

Bradford Engineering Society:—Technical College, Bradford. Mr. Frank Wigglesworth will read a résumé of the late Professor G. F. Charnock's last paper on "The Mechanical Transmission of Power." 7.30 p.m.

TUESDAY, NOVEMBER 18TH.

Institution of Civil Engineers.—Great George-street, Westminster, S.W. 1. Paper for discussion, "The Lochaber Water Power Scheme," by Mr. W. T. Halcrow. 6 p.m.

Institution of Electrical Engineers: Scottish Centre.—The annual dinner will be held at the Central Station Hotel, Glasgow. 6.30 for 7 p.m.

Sheffield Metallurgical Association.—198, West-street, Sheffield. "Technique of the Developments of Micro-structures," by Mr. T. H. Arnold. 7.30 p.m.

Staffordshire Iron and Steel Institute.—Girls' High School, Dudley. "Some New Views on Smelting and Re-melting Processes," by Mr. J. E. Fletcher. 7 p.m.

WEDNESDAY, NOVEMBER 19TH.

British Electrical and Allied Manufacturers' Association.—At the Connaught Rooms, Great Queen-street, W.C. 2. Annual dinner. 7 for 7.30 p.m.

Institution of Automobile Engineers.—Park Lane Hotel, Piccadilly, W. 1. Annual dinner. 7.30 p.m.

Institution of Civil Engineers.—Great George-street, Westminster, S.W. 1. Students' meeting. Address by Mr. A. T. Black. 6.30 p.m.

Institution of Municipal and County Engineers.—At the Public Health Congress, Royal Agricultural Hall, Islington. "Modern Treatment and Disposal of Sewage, especially as Affecting Trade Wastes," by Mr. T. P. Francis. 11 a.m.

Junior Institution of Engineers.—Visit to the Locomotive Running Sheds of the Great Western Railway Company at Old Oak Common. 2 p.m.

Royal Meteorological Society.—49, Cromwell-road, South Kensington, S.W. 7. Meeting at 5 p.m.

Royal Microscopical Society.—B.M.A. House, Tavistock-square, London, W.C. 1. Meeting at 5.30 p.m.

Royal Society of Arts.—John-street, Adelphi, London, W.C. 2. Ordinary meeting. 8.30 p.m.

THURSDAY, NOVEMBER 20TH.

British Waterworks Association.—Agricultural Hall, Islington, London, N.1. Winter session. "The Afforestation of Watersheds," by Mr. R. L. Robinson; "The Land Drainage Act, 1930, in Relation to Rivers Pollution Prevention," by Mr. A. Bebbington; "The Rural Water Supply Problem," by Mr. Douglas F. Worger. 2.30 p.m.

Institute of Metals: London Local Section.—At the Royal School of Mines, South Kensington, S.W. 7. "Some Non-ferrous Metals in Chemical Engineering," by Dr. Richard Seligman. 8 p.m.

Institution of Automobile Engineers.—Joint meeting with the Royal Aeronautical Society, at Royal Society of Arts, John-street, Adelphi, W.C. "Recent Developments in Engine Cooling with some Reference to Oil Cooling," by Captain Swan. 7.30 p.m.

Institution of Electrical Engineers.—In the Lecture Theatre of the Institution, Savoy-place, Victoria Embankment, W.C. 2. "Some Data Concerning Railway Electrification in Italy," by Mr. G. Bianchi. 6 p.m.

North-East Coast Institution of Engineers and Shipbuilders: Tees-side Branch.—In the Technical Institute, Corporation-road, Middlesbrough. "Ship Repairing," by Mr. G. Tristram Edwards. 7.30 p.m.

FRIDAY, NOVEMBER 21ST.

Chelsea Polytechnic.—Manresa-road, London, S.W. 3. Prize distribution and address by her Grace the Duchess of Atholl. 8 p.m.

Diesel Engine Users Association.—In Caxton Hall, Caxton-street, Westminster, London, S.W. 1. "The Application of Diesel Engines to Road Transport," by Major W. H. Goddard. 3.30 p.m.

Institution of Electrical Engineers: Meter and Instrument Section.—At the Florence Restaurant, 56, Rupert-street, London, W. 1. Dinner. 6.45 for 7 p.m.

Institution of Mechanical Engineers.—Storey's-gate, St. James's Park, London, S.W. 1. General meeting. "The Coefficients of Heat Transfer from Tube to Water," by Mr. A. Eagle and Mr. R. M. Ferguson. 6 p.m.

Institution of Professional Civil Servants.—Lecture Hall, Surveyors' Institution, 12, Great George-street, Westminster, S.W. 1. "Some of Our Road Problems," by Colonel C. H. Bressey. 5.30 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Informal meeting. Lecture, "Ancient Clocks and Horological Curiosities," by Mr. R. P. Howgrave Graham, illustrated by slides and exhibits. 7.30 p.m.

MONDAY, NOVEMBER 24TH.

Institution of Mechanical Engineers: Graduates' Section, London.—Storey's-gate, St. James's Park, London, S.W. 1. "Machine Tools," by Mr. C. H. Russell. 6.45 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. Cantor Lecture, "Modern Domestic Scientific Appliances," by Professor C. R. Darling. 8 p.m.

TUESDAY, NOVEMBER 25TH.

Design and Industries Association.—At the Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. Discussion, "Modern Electric Lighting and Lighting Fixtures." Speakers, Mr. H. D. Best and Mr. Raymond McGrath. 8 p.m.

Institution of Mechanical Engineers: Midland Branch.—Queen's Hotel, Birmingham. Dinner to meet the President. 6.45 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. "The Development of Air Communication in Africa," by Mr. G. E. Woods Humphery. 4.30 p.m.

Sheffield Metallurgical Association.—198, West-street, Sheffield. "Preparation of Standard Steels," by Mr. G. C. Waite. 7.30 p.m.

WEDNESDAY, NOVEMBER 26TH.

Institution of Engineers-in-Charge.—Joint meeting with the Association of Supervising Electrical Engineers. Magnet House, Kingsway, W.C. 2. "Ventilation by Air Movement," by Mr. H. J. Eley. 7.15 p.m.

Newcomen Society.—Caxton Hall, Westminster, S.W. 1. Annual general meeting. "Early Fire Extinguishing Engines," by Mr. Rhys Jenkins. 5.30 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. "The Chemical Constitution of Coal," by Professor W. A. Bone, F.R.S. 8 p.m.

THURSDAY, NOVEMBER 27TH.

British Chemical Plant Manufacturers' Association.—Jules Restaurant, Jermyn-street, London. Annual dinner. 7 for 7.30 p.m.

Co-ordinating Committee Representing Staffordshire Iron and Steel Institute, Birmingham Metallurgical Society (Inc.), Birmingham Local Section of the Institute of Metals.—In Room No. 7, the Chamber of Commerce Buildings, Birmingham. "Solders," by Mr. O. F. Hudson. 7 p.m.

FRIDAY, NOVEMBER 28TH.

Institution of Mechanical Engineers.—Storey's-gate, St. James's Park, London, S.W. 1. Informal meeting. Discussion on "Export Trade Emancipation," introduced by Mr. Edward Batten. 7 p.m.

Institution of Municipal and County Engineers.—Scottish District meeting at County Buildings, Paisley. Address by Mr. Thomas Somers on the Sixth International Road Congress at Washington, D.C. 2 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. "Photography Applied to Science," by Mr. G. H. Willett. 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—In the Lecture Theatre of the Mining Institute, Newcastle-upon-Tyne. "The Ocean-going Tramp Steamer from the Owner's Point of View," by Mr. W. Stanley Hinde. 6 p.m.

SATURDAY, NOVEMBER 29TH.

Co-ordinating Committee Representing Staffordshire Iron and Steel Institute, Birmingham Metallurgical Society (Inc.), Birmingham Local Section of the Institute of Metals.—In the Queen's Hotel, Birmingham. Reception, 6.30 to 7 p.m.; dinner, 7 p.m.

MONDAY, DECEMBER 1ST.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. Cantor Lecture, "Modern Domestic Scientific Appliances, Lecture II.," by Professor C. R Darling. 8 p.m.

TUESDAY, DECEMBER 2ND.

Institution of Automobile Engineers.—Royal Society of Arts, John-street, Adelphi, W.C. 2. "Some Experiments on the Factors Affecting the Motion of a Four-wheeled Vehicle when some of its Wheels are Locked," by Mr. J. Bradley and Mr. S. A. Wood; "Factors Affecting the Behaviour of Rubber-tired Wheels on Road Surfaces," by Mr. J. Bradley and Mr. R. F. Allen. 7.45 p.m.

THURSDAY, DECEMBER 4TH.

Institution of Civil Engineers: Birmingham and District Association.—At the Queen's Hotel, Birmingham. Annual dinner. 6.30 for 7 p.m.

Institution of Mechanical Engineers: North-Western Branch.—Engineers' Club, Albert-square, Manchester. Annual dinner. 6.30 for 7 p.m.

FRIDAY, DECEMBER 5TH.

Institution of Mechanical Engineers.—Storey's-gate, St. James's Park, London, S.W. 1. Extra general meeting. "Machinery and Methods of Manufacture of Sheet Glass," by Professor W. E. S. Turner. 6 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Informal meeting. "Oil Burning for Domestic Central Heating," by Mr. R. L. Mayston. Slides. 7.30 p.m.

MONDAY, DECEMBER 8TH.

Imperial College of Science and Technology.—Goldsmiths' Hall, London, E.C. 2. Imperial College dinner. 7 for 7.30 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. Cantor Lecture, "Modern Domestic Scientific Appliances, Lecture III.," by Professor C. R. Darling. 8 p.m.